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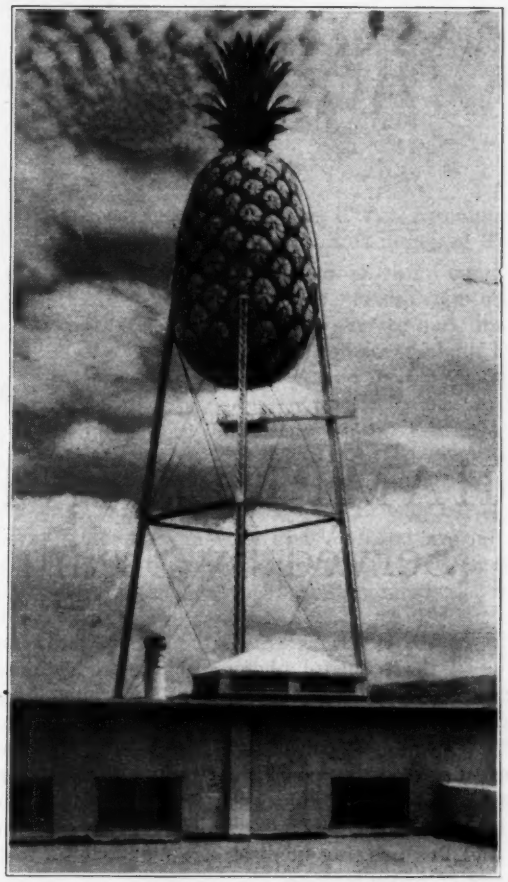


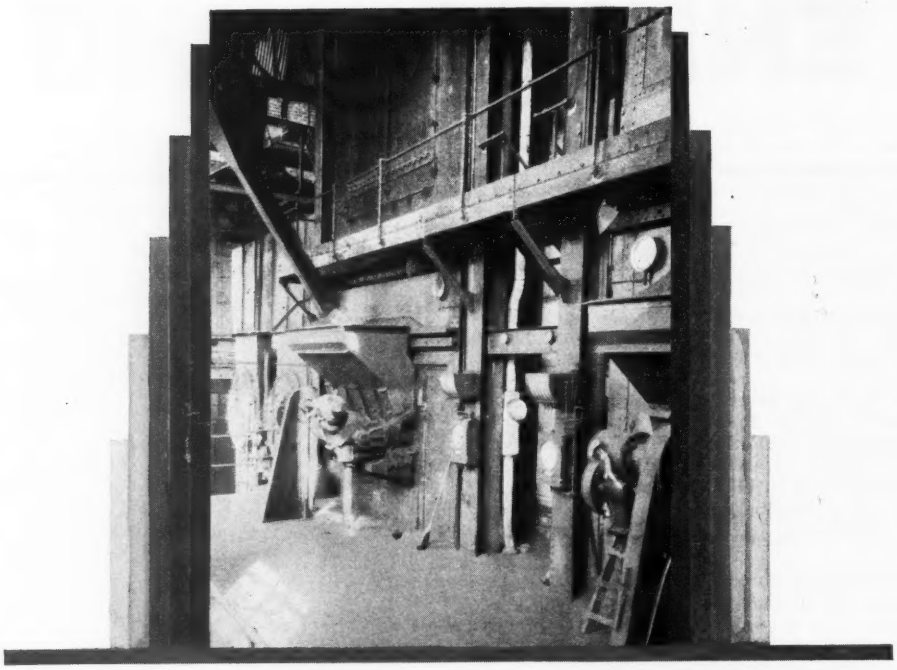
A Pineapple Pine

TO GET ATTENTION was the motive of those who raised the pineapple illustrated above. But it is not a picture of Capone's headquarters. Pineapples, a la Al Capone, are full of powder. This pineapple will not explode; it would not interest Capone, for it is full of water.

Inspiration was another motive of the Hawaiian Pineapple Co. in putting the pineapple on top of its factory. That pineapple was set up as an inspiration to the millions of developing pineapples in the surrounding country to attain large size and be full of juice.

Such pineapples should be worth getting. But we, in this country, would see little of them were it not for the good offices of refrigeration. That enables us to get them as fresh and fragrant as when they were picked.

Other applications and possibilities of uses of refrigeration are discussed in another part of this issue.



CHAMPION INTERNATIONAL CO.
Served by Steam and Hydraulic Plants

AMONG THE MANY thousands who admire the beautiful photographic reproductions in the pages of the National Geographic Magazine each month, there must be many who at one time or another have paused to admire the excellence of the paper on which that magazine is printed and which is so largely responsible for the success of its halftone work. Its whiteness, its smooth surface and fine printing qualities are high tribute to the progress of paper making.

It would, no doubt, be of interest to describe the processes involved in making this paper and the mill which produces it but that is a subject for a magazine devoted to the paper industry, not for a power plant journal, so here we shall have to be content with a description of the power plant which furnishes the power, light and heat for this mill.

The plant of the Champion International Co. is located at Lawrence, Massachusetts, and is devoted entirely to the making of high grade coated book papers. During the past few years, its power demands have been increasing and for some time the company has been gradually rebuilding and enlarging its power producing facilities. Originally, the power plant consisted of an old boiler house with six 400-hp. horizontal return tubular boilers. These boilers, installed in 1902, supplied steam both for heating and for power purposes. A 20 by 42-in., 750-hp. Filer & Stowell, twin, noncondensing engine, running at 100 r.p.m., was belted to super calenders. This engine is still in operation. At the present time, however, a 200-kw. a.c. generator is driven from the same countershaft as the super calenders, this machine being synchronized with the main generator in the present turbine room and with the hydroelectric system.

Within the past year, the use of the old boilers has been discontinued and a new boiler house built. This new boiler house occupied about half the space (ground area) of the old boiler house, two of the old boilers being retained for emergency service. These, however, are soon to be dismantled and the new boiler house extended so as to provide room for another new boiler.

At present, the new boiler house has installed in it, two 552-hp. water-tube boilers fired by underfeed stokers. These boilers, while built for 400 lb. pressure, are now operated at only 150 lb. pressure to conform with the steam requirements of the present turbine. In the near future, however, a new 400-lb. pressure turbine is to be installed and then the boiler pressure will be raised to 400.

A feature which the power generating equipment at this plant has in common with other industrial plants which grew up, so to speak, in the days before the universal application of electric power, is that the various elements of the power plant are located some distance from each other. This, of course, is due to the fact that in former days, because of the limitations imposed by direct mechanical drive, it was necessary to locate the prime mover close to the machines in the mill. Under these conditions, naturally enough, the available space

around the boiler house was used for purposes other than power generation, so when the direct mechanical drives finally were replaced by electric generating and transmission equipment, and when it would have been logical to locate the electric generating equipment adjacent to the boiler room, space was no longer available for this purpose. For a reason such as this, the turbine room at the Champion International plant is located some distance from the boiler house. The Filer and Stowell engine referred to previously is located in still a different part of the mill.

Supplementing the steam-driven electricity supply is also a hydroelectric plant, with two generating units. This plant is located within the mill grounds proper, close to the steam turbine room, and utilizes a 27-ft. head. Water for the hydroelectric system is taken from the canal system of the Essex Company and passes through the hydraulic turbines into the Spicket River. The canals are fed from the Merrimac River. This combination of steam and hydro plants provides an extremely reliable power supply for the mill and enables power to be produced at a low cost. This hydroelectric plant is about 5 yr. old.

With this preliminary general description, it will now be of interest to consider the design features of the plant in greater detail.

The New Boiler House

An exterior view of the new boiler house is shown in Fig. 3, with what remains of the old boiler house in the foreground. It is a modern brick structure with a temporary wall on one side so that it may be extended in the near future.

Coal is delivered by rail and is dumped from cars run on the trestle shown in Fig. 3 into a storage yard on both sides of the trestle adjacent to the boiler house. From this storage, a Browning locomotive crane equipped with a ¾-yd. bucket removes the coal and delivers it to a hopper just outside the boiler room as indicated in Fig. 5. Passing through the hopper, the coal is crushed, if necessary, and then by means of a bucket elevator it is elevated to the upper part of the boiler house where a right and left screw conveyor distributes it uniformly in the overhead bunkers. Each of the two steel bunkers has a capacity of 70 t. From the bunkers, a weigh larry equipped with a Richardson automatic coal scale delivers the coal to the stoker hoppers. With the exception of the crane and the automatic scale, all the coal handling equipment was furnished by the Stephens-Adamson Mfg. Co.

The coal used at present is New River nut and slack of about 14,500 B.t.u. heat content. A typical analysis is as follows:

Moisture	2.13	per cent
Volatile	19.85	" "
Fixed carbon	72.05	" "
Ash	5.97	" "
Sulphur	0.68	" "

A coal storage of from 500 to 1000 t. is maintained regularly but, if necessary, this can be increased 2000 t.

New boiler equipment consists of two Combustion Engineering, Walsh-Weidner type cross-drum boilers, each with 5520 sq. ft. of heating surface and fired by Taylor underfeed stokers. The boilers are built for a safe working pressure of 400 lb. and have 54-in. steam drums and 4-in. diameter tubes. Each boiler has four 3½-in. Ashton safety valves, one 2½-in. Edward extra heavy feed stop valve, one 2½-in. Edward check valve, one 2½-in. Edward drum head stop and check valve, two 2½-in. Yarway Tandem Type B blowoff valves, one Yarway water column with high and low level alarms, and one Type E Stets feedwater regulator. Each boiler is provided with 8 elements of manually operated Diamond soot blowers.

An interesting feature of this plant is the waste heat economizer. A considerable amount of waste heat is available from the soda recovery process in the paper mill. This is passed through a waste heat economizer in the boiler room where the heat is recovered in the boiler feedwater.

As stated previously, the boiler pressure maintained

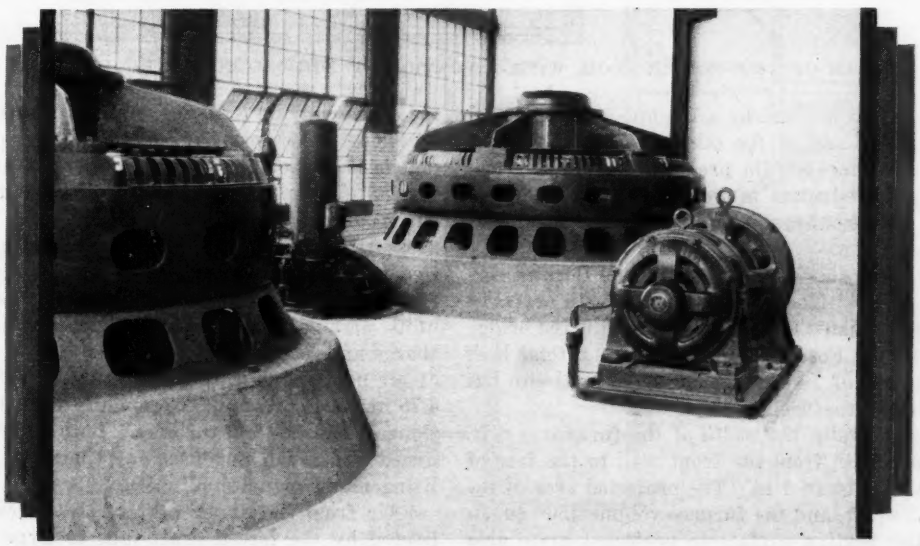


FIG. 1. TWO HYDROELECTRIC GENERATORS OPERATE ON A 27 FT. HEAD

at the present time is only 150 lb. although the boilers are built for 400 lb. The boilers are fitted with Foster superheaters. The initial superheater arrangement consists of 24 U-bend elements, in 12 double loop nests, each superheater designed to add 80 deg. superheat when the boiler is operating at 320 per cent rating under 145 lb. steam pressure. When the new turbine is installed and the pressure is raised, 24 additional elements will be installed and the superheat raised to 154 deg. when the boiler is operating at 200 per cent rating at 390 lb. pressure.

Each boiler is fired by a Type H, 5-retort, 33-tuyere, Taylor stoker equipped with power dump. Both stokers are driven from a common line shaft underneath the floor, and driven at one end by a 7½-hp., 4-speed, 600-v. Louis Allis motor and at the other by a Moore steam turbine designed for 400 lb. pressure and 15 lb. back pressure. Speed reduction between the turbine and the line shaft is effected through the agency of a Cleveland reduction gear.

Furnaces have side walls consisting of Bernitz carborundum air-cooled blocks to the fire line with ordinary refractory above that. The rear wall which is the bridge wall, consists of a Foster water back with a total heat absorbing surface of 76 sq. ft. The front wall also has Bernitz blocks to the fireline.

Between side walls, the width of the furnace is 8 ft. 9 in. and the length from the front wall to the face of the bridge wall is 14 ft. 1 in. The projected area of the grate is 123.2 sq. ft. and the furnace volume 1600 cu. ft. Ratio of boiler heating surface to projected grate area is 45.1 while the ratio of furnace volume to boiler heating surface is 0.29. At a boiler rating of 320 per cent, the furnaces are designed for a heat liberation of 57,000 B.t.u. per cu. ft. per hr.

The furnaces are provided with Allen-Sherman-Hoff ash hoppers, with hand-operated ash gates. Ash is dumped into a two-wheel buggy and delivered to a concrete ash pit just outside the boiler house. The same crane which handles the coal is used to remove the ash from this ash pit and deliver it to motor trucks.

Draft System

Both forced draft and induced draft are used; there is a forced draft fan and an induced draft fan for each boiler. The actual arrangement is evident from the accompanying drawings. Forced draft fans are No. 36, Type RB, Green, full-housed fans consisting of a double inlet housing arranged for top horizontal discharge. The maximum capacity of these units is 23,300 cu. ft. of air per min. at 80 deg. F. and 7½ in. static pressure at 1392 r.p.m. Each fan is driven by a 55-hp. General Electric turbine.

Induced draft fans are also Green Fuel Economizer units, arranged for double inlet and vertical down discharge and having maximum capacities of 43,500 cu. ft. of air per minute at a temperature of 445 deg. F. and 4.75 in. static pressure. These units are driven by 70-hp. General Electric Co. turbines. Both the forced and induced draft fan turbines are controlled by Ruggles-Klingemann regulators.

Air from the upper part of the boiler house is delivered by the forced draft fans to Type C-14, Ljungstrom regenerative air preheaters, each boiler having its

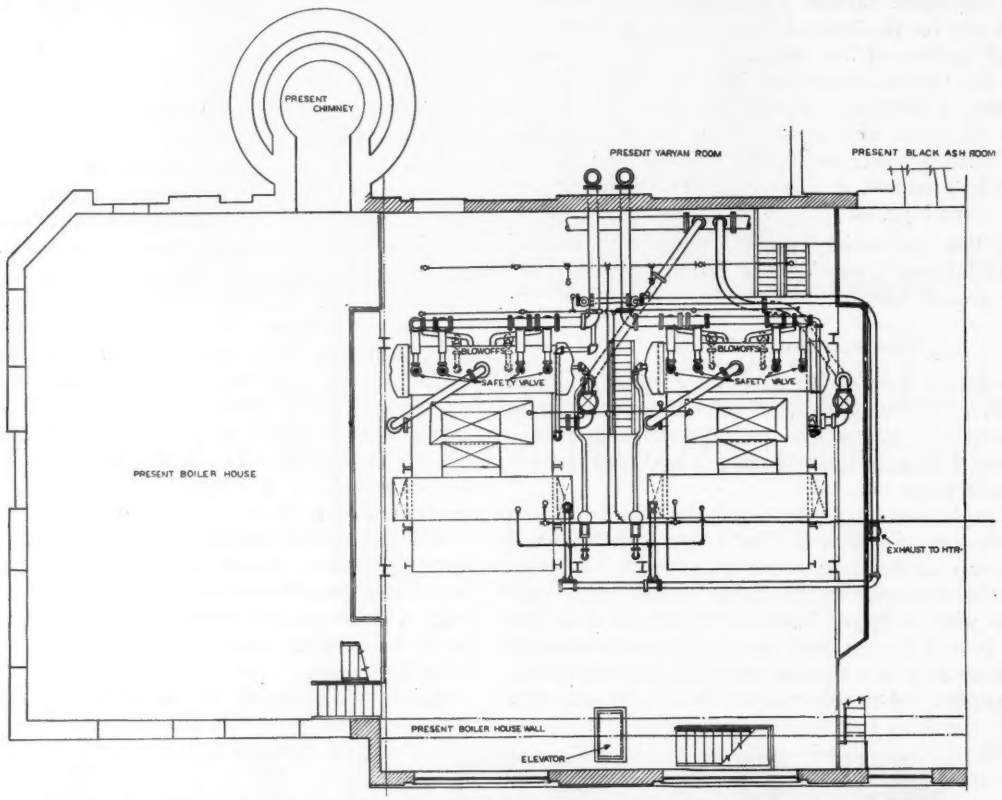


FIG. 2. PLAN OF NEW BOILER ROOM, WITH A PORTION OF THE OLD BOILER ROOM AT THE LEFT

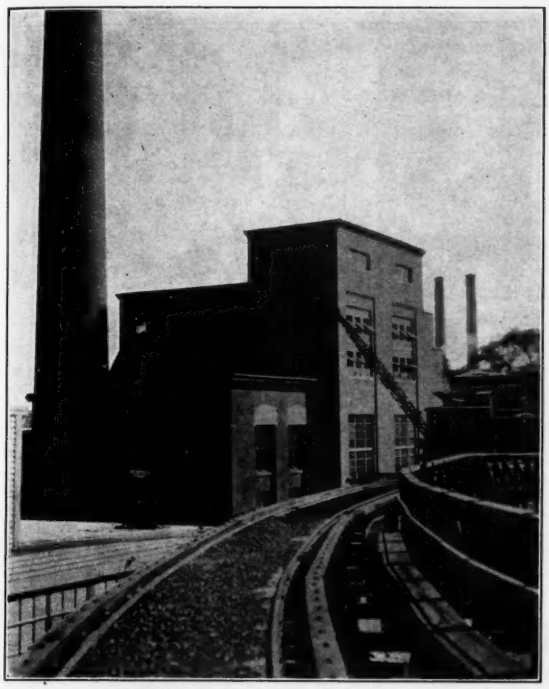


FIG. 3. EXTERIOR VIEW SHOWING NEW BOILER HOUSE AND A PORTION OF THE OLD IN THE FOREGROUND

own preheater. Normal temperatures obtained with these heaters, when handling 92,000 lb. of air per hour are as follows:

Gas temperature entering preheater....725 deg.
Gas temperature leaving preheater .....445 "
Air temperature entering preheater .... 80 "
Air temperature leaving preheater .....390 "
Each heater has 10,000 sq. ft. of heating surface.

For disposing of the products of combustion, an 8-ft. diameter, 175-ft. stack is provided. This chimney is of common red brick and was built when the first boilers were installed in 1902.

FIG. 4. THE PRESENT TURBINE GENERATOR

Instruments in the boiler room include Bailey boiler meters and multiple draft gages, Cochrane V-notch water meter and Foxboro recording thermometers and pressure gages.

Feedwater Supply

Boiler feedwater is river water. This is taken from the main mill service supply and together with all returns brought back is delivered to a Cochrane Corp. open feedwater heater, where it is heated to 200-205 deg. F. From the heater, it is pumped through a Green fuel economizer, utilizing waste heat from the soda recovery process. Here, its temperature is raised to 275 deg. at which it enters the boiler. At the present time, two Worthington duplex steam feed pumps are provided but when the boiler pressure is raised to 400 lb., these will probably be replaced by centrifugal units.

Electric Generating Equipment

All current used throughout the paper mill is 3-phase, 60-cycle current generated at 600 v. At present, the steam-driven generating equipment consists of a 1000-kw. General Electric, Curtis, extraction turbine, operating condensing, driving a 1000-kw., 600-v. gen-

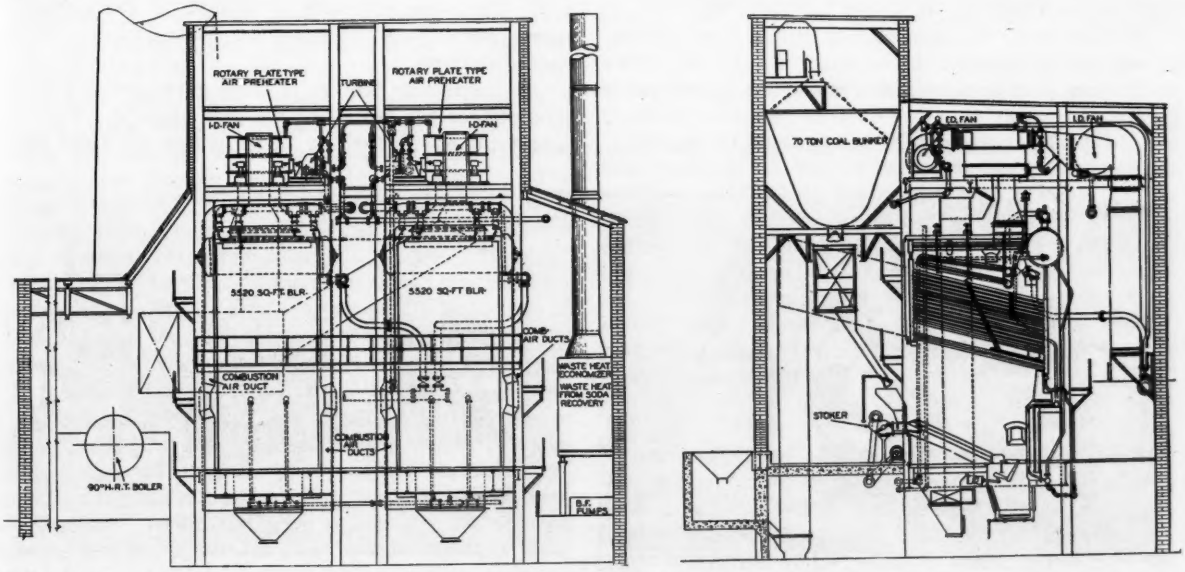


FIG. 5. ELEVATIONS OF NEW BOILER EQUIPMENT

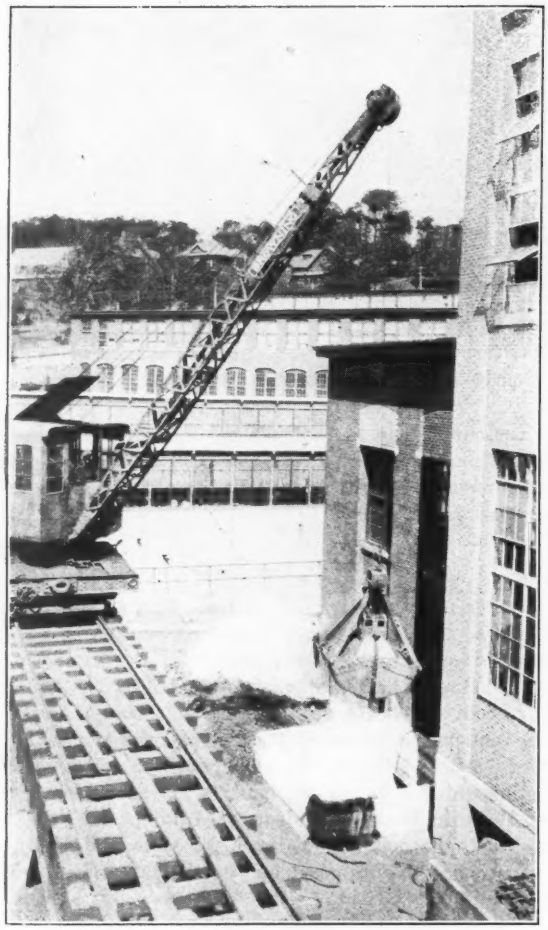


FIG. 6. CRANE REMOVING ASH FROM OUTDOOR ASH HOPPER

erator. The turbine is supplied with steam at 145 lb. pressure and 50-deg. superheat and exhausts into a Westinghouse Leblanc jet condenser. Steam, for process work is bled from the turbine at 6 lb. pressure.

Excitation for this generator is supplied by a motor-driven exciter installed in the water wheel room. This machine supplies excitation current for the hydroelectric generators as well.

In the near future, it is the intention of the engineering department to install a 2000 or 2500-kw., 400-lb. pressure turbine generator, designed to bleed at 100 lb. and to exhaust at 10 lb. pressure.

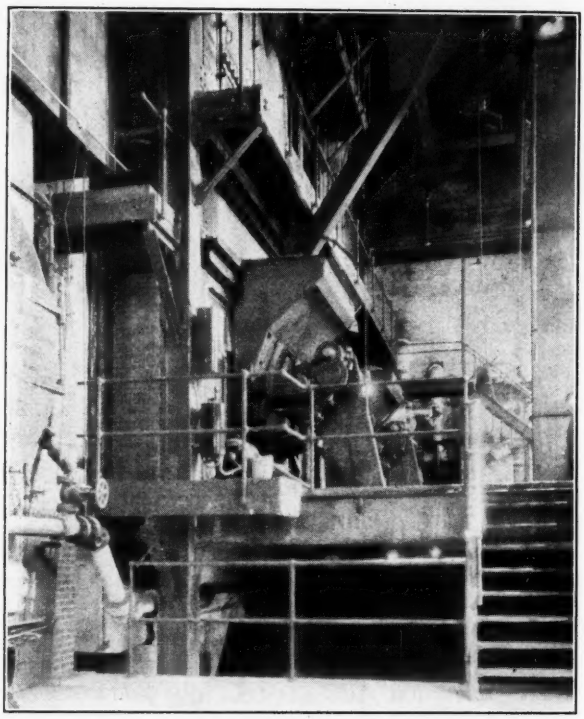


FIG. 7. A VIEW TAKEN FROM THE OLD BOILER ROOM LOOKING TOWARD THE NEW

Hydroelectric Equipment

Two hydroelectric generators are installed, one rated at 1000 kv-a. and the other at 500 kv-a. Both of these units are James Leffel & Co. vertical units, the large one consisting of a 1000-kv-a., 600-v., 80-per cent power factor Westinghouse generator driven by a water turbine operating under a 27-ft. head. The small unit, also a Westinghouse generator, is similar in every respect except size. Both machines are controlled by Woodward governors.

An interesting feature of these governors is a novel arrangement for recording the gate opening. This arrangement was devised by L. B. Rogers, the chief engi-

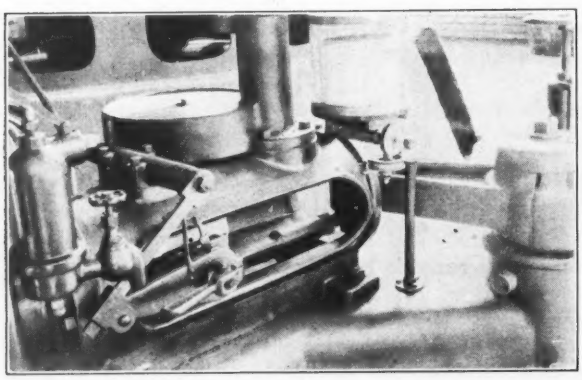


FIG. 8. GATE OPENING RECORDING MECHANISM, INSTALLED ON TURBINE GOVERNOR

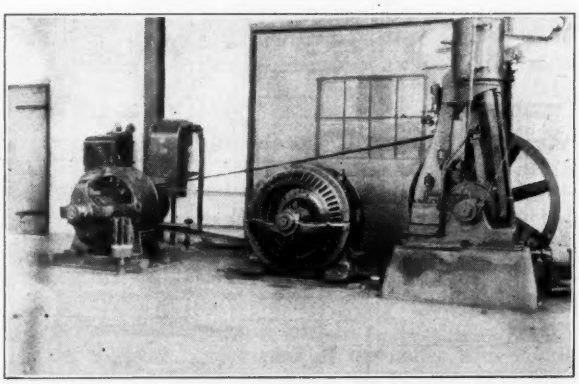


FIG. 9. EMERGENCY EXCITER UNIT CAN BE DRIVEN EITHER BY A MOTOR OR BY A VERTICAL STEAM ENGINE

neer, and is shown in Fig. 8. A cord attached to the gate opening mechanism is arranged so as to operate a pen on a recording drum driven by a clockwork. An indicator reducing motion is used to reduce the motion of travel of the gate mechanism to the amount required by the drum. With this arrangement, a 24-hr. record is obtained showing the amount of gate opening of the turbine at any time.

Beside the water wheel generators, the water wheel room also contains two exciter units, one the motor-driven unit already referred to in connection with the steam-driven generating unit and the other an emergency exciter unit consisting of a d.c. generator driven by a vertical steam engine or a motor. The regular unit is a Westinghouse unit consisting of a 90-hp., 550-v. induction motor driving a 60-kw., 125-v. d.c. generator.

The standby exciter is shown in Fig. 9. It consists of a 60-kw. Westinghouse d.c. generator belted to both a Western Electric motor and a vertical engine. Either belt can be slipped on or off, making it possible to drive the generator by steam or electrically as desired.

Taken as a whole, this is a very interesting example of an industrial power plant, utilizing all its resources to the best possible advantage. While not a show plant, the engineering features have been well worked out and excellent performance is obtained. With the boilers operating at about 150 per cent rating, an average daily operating efficiency of 83 per cent is obtained. The power load and process steam load is practically balanced, due to the operation of the hydroelectric plant which drops off the excess and absorbs the surplus.

The new boiler house was designed and constructed by Charles T. Main, Inc., of Boston, under the personal direction of M. K. Bryan of that company. It is of interest in this connection to know that the original boilers, placed in this plant in 1902 were designed by Dean and Main.

For the information on which this article is based we wish to express our indebtedness to L. B. Rogers, chief engineer of the Champion International Co. and to Chas. T. Main, Inc., of Boston.

New Heat Exchanger Uses the Flash Principle

SIMPLE METHOD OF RECOVERING HEAT BY DIRECT CONTACT FROM MATERIALS WHICH CANNOT BE USED IN A CLOSED SYSTEM; 42 PER CENT STEAM SAVING REPORTED IN PAPER MILLS. BY D. K. DEAN*

MANY INDUSTRIAL PLANTS use steam for process work and in practically every instance large savings are possible by the judicious use of heat exchangers. The means of recovering heat in processing is through conventional shell and tube type heat exchangers. This simple method is not applicable to all processes, however, due to solids in suspension which would quickly plug up the ordinary heat exchanger.

Paper mills form an excellent example of industrial plants having large quantities of high temperature liquids, the heat of which is wasted through inability to pass the liquids through heat exchangers. Recently a reclamation system which does not involve running the pulp filled water of paper mills through a tubular heat exchanger has been developed and patents applied for.

In many paper mills, especially those in which book or newspaper stock is re-washed, large quantities of pulpy material are heated and digested in water at temperatures ranging from 170 to 200 deg. F. The processes used are generally continuous, a steady feed of fresh water and pulp being supplied to replace cooked pulp which is carried to the next process. It is not desirable customarily, to maintain high temperatures in the pulp after it leaves the digesters. Therefore, if the heat can be transferred from the cooked pulp to the raw process feed, large fuel savings can be realized.

Many attempts have been made to effect the desired heat transfer in tubular heat exchangers but all have failed, due to plugging soon after going to service. The newly developed method, which has been in successful operation for about 9 mo., utilizes the principle of flash evaporation. Water and pure vapor only are used in the heat transfer apparatus and the heat exchange takes

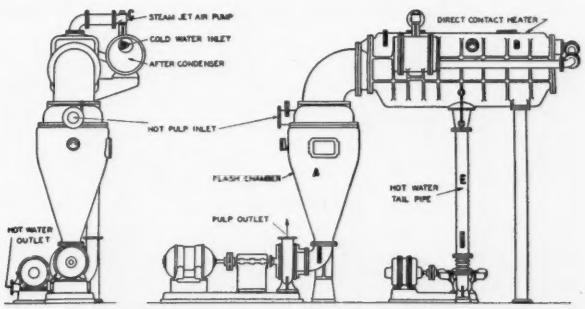


FIG. 1. SINGLE STAGE HEAT EXCHANGER SYSTEM FOR PAPER MILL

place in a direct contact heater so that there are no tubes to be kept clean or to leak.

Figure 1 illustrates a simple arrangement of this heat exchange system. A flash chamber is connected to a direct contact heater equipped with a steam jet air pump. The digested or cooked pulp enters the flash chamber at the top and is spread out automatically, providing sufficient free area for the necessary vaporization. The steam jet air pump attached to the direct contact heater maintains a vacuum within the system. Steam from the hot, pulp filled liquid is flashed off and passes to the heater.

SINGLE STAGE ALLOWS 40 PER CENT STEAM SAVINGS

Raw water fed to the process passes first through the after-condenser of the steam jet air pump, absorbing the heat of the steam used to maintain the vacuum. The feedwater is then sprayed into the heater where it comes into direct contact with the steam and absorbs the latent heat of the steam flashed from the pulp. It is

*Development Eng., Foster Wheeler Corp., New York, N. Y.

thus possible to heat the feedwater to a temperature within a few degrees of the temperature corresponding to the vacuum in the heater. The mixture of raw water and condensate flows down the tail pipe of the heater to the suction of the raw water pump which delivers it to the process. The pulp within the evaporator, after being cooled to the temperature corresponding to the vacuum by generation of flash steam, flows into the suction of the pulp pump. This pump delivers the pulp to the next step in the process.

In this system, if the amount of raw water feed is equal to the amount of pulp flowing through the process, approximately 40 per cent of the fuel necessary to raise the temperature of the pulp from an inlet temperature of 50 to a desired temperature of 200 deg. F. would be conserved.

Although the single-stage system described above offers large economies, increased savings may be accomplished by the adoption of two or more stages. The increased number of stages has the same effect as a

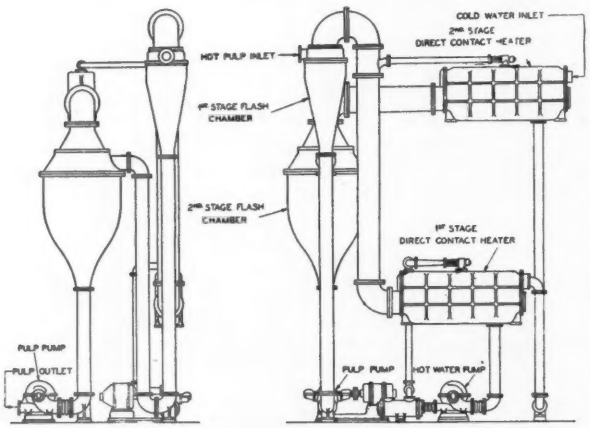


FIG. 2. DOUBLE STAGE HEAT EXCHANGER AS INSTALLED

counter-flow arrangement in the ordinary heat exchanger apparatus. Figure No. 2 shows the arrangement of the two stage system which has been installed in a prominent New England paper mill.

Actual Installation Shows 42 Per Cent Savings

In the two-stage system hot pulp enters the first stage flash chamber at the top. A single stage steam jet air pump maintains a moderate vacuum in this flash chamber and the first stage heater, with which it is connected. The steam jet air pump is equipped with a surface after condenser. Steam is flashed from the pulp and water mixture in the flash chamber and passes to the heater while the pulp itself drains through a loop-seal to the inlet of the second flash chamber where a higher vacuum is maintained. The second stage is equipped with a direct contact heater and a steam jet air pump similar to the first stage except that the steam jet air pump discharges into the vapor line of the first stage flash chamber, eliminating the necessity of an after-condenser. The pulp, after flashing in the second stage flash chamber, is delivered to the system by the pulp pump for further processing.

Raw water to be heated enters the second stage heater where it is brought into direct contact with the vapors and moderately heated. The mixture of raw water and condensate flows through a loop seal into the first stage heater where it is again brought into direct contact with the vapor. The temperature of the vapors in the first stage heater is higher, due to the lower vacuum, allowing the raw water to be further heated. The feed water and condensate flow through the tail pipe into the water pump which forces this water through the after condenser of the first stage steam jet air pump, thus recovering the heat of the steam used to maintain the vacuum. The entire system is simple in its operation and construction. The fact that there are no moving parts in the heat exchanger apparatus eliminates the possibility of shutdown due to clogging with pulp. Operating costs are, therefore, kept at a minimum.

A comparison of the operating records at this plant before and after this two-stage system was installed shows considerable saving due to the heat recovery apparatus. On June 12, 1929, the through-put of the mill was 15 per cent more than on the same date of the previous year. The steam consumption, however, with increased through-put was only 210,000 lb. per day during 1929 as compared with 315,000 lb. for the same date of 1928. Taking into account the increased through-put, the steam saving for the entire mill resulting from the use of the heat exchanger system, amounts to about 42 per cent. Arrangements have been made to install a duplicate unit.

This same system is now being adapted for use in connection with pulp digesters. When digesters are blown off, there is a large heat loss. Part of the heat loss is in steam which is flashed off in the blow-pit and which is generally allowed to escape to the atmosphere. The balance of the loss is in the hot liquor.

Saving in heat, which can be accomplished by adopting in digester mills a system similar to that described above, is large, because of the high temperature of the steam and liquor.

Bureau of Mines Loans Industrial Films

Department of Commerce, Bureau of Mines, is sending out a list of motion picture films showing mining and manufacturing processes that may be borrowed for use on application to the Pittsburgh Experiment Station, Pittsburgh, Pa., or various field offices and stations of the bureau of mines. The films were produced under the direction of the Bureau, supervised by M. F. Leopold, Head Motion-Picture Production Section, and are distributed under the direction of R. A. Wood, supervising engineer, Graphic Section, Bureau of Mines Experiment Station, Pittsburgh, Pa. Descriptive list of films with a list of the stations from which they can be obtained may be had on application to Mr. Wood. The films are mostly 35 mm. in width but some are also available of the 16-mm. width. Each reel consists of approximately 1000 ft. and requires about 15 min. to show.

When a safety valve opens, the pressure must drop a considerable amount before the valve again closes. This difference or drop in pressure is known as the blowdown and, with most safety valves, can be varied somewhat by means of a special ring built into the valve. It should not be less than 4 per cent of the pressure according to the Boiler Code.

An answer to

What Part Does the Power Plant Play in a Modern Railway Terminal?

By P. E. Roll
Texas & Pacific Ry. Co.
Dallas, Tex.

Direct steaming of locomotives uses 68 per cent of steam . . . fuel saved was 20 per cent and time saved was 35 per cent by the use of direct steaming . . . fuel saving per annum is 22 per cent of the investment . . . 480 lb. of 225 lb. steam required to deliver 1000 gal. of wash and filling water . . . white interior of roundhouse . . . 450 lb. of 125 lb. steam required to heat 1000 gal. of oil for locomotive . . . overall boiler efficiency 80 per cent.

IN SUCCESSFUL operation for more than a year, the Lancaster Yard Power Plant* of The Texas & Pacific Railway Co. at Fort Worth, Texas, has proved its capacity for fulfilling the unusual and exacting demands for steam at the largest engine terminal on the system. The boiler room furnishes steam for compressing air, pumping and heating fuel oil, steam hammers, locomotive boiler washing plant pumps and heat for buildings but was designed primarily to provide steam for the direct steaming of locomotives in the roundhouse.

Originally two 511-hp. water-tube boilers designed for 250-lb. working pressure, with gas burners and emergency oil burners were installed, but the character of the feedwater required such frequent removal of a boiler from service for cleaning and renewal of tubes that, after three months of operation, it was decided to install a third unit and thereby provide a stand-by boiler.

Unusual and highly fluctuating boiler loads were experienced during the first months of operation. The peak demands on the boiler plant were 75,000 lb. per hr. and the minimum was 14,000 lb. per hr. with 15,000 to 20,000 lb. per hr. instantaneous increases and decreases in load. This condition demanded the application of some system whereby the consumption of steam could be controlled. Since 68 per cent of the steam produced was required for direct steaming, several methods of signaling or communication between the boiler room and the roundhouse were considered with the view of better balancing the load. None of the schemes devised transmitted the information that would keep the roundhouse forces fully advised of conditions in the boiler room and enable them so to arrange their operations as to control the peak loads.

Finally this problem was solved in a simple and inexpensive manner. The original installation of metering equipment in the power plant included a flowmeter which records and integrates the flow of steam through the main to the roundhouse. A duplicate recorder, connected to, and repeating the recording of the meter in the power plant, was installed in the roundhouse at a central point, where the workmen who steam the locomotives are given their assignments. The foreman in charge of washing and steaming locomotives was instructed that the recorder must not indicate a steam flow to the roundhouse exceeding 40,000 lb. per hr.

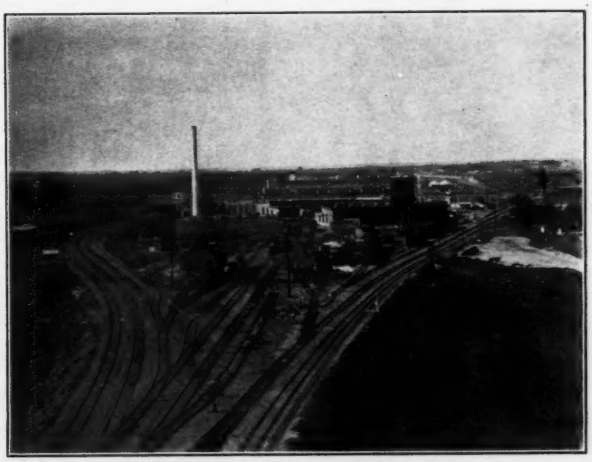


FIG. 1. GENERAL VIEW OF LANCASTER YARD WITH THE POWER PLANT AT THE LEFT

Each succeeding month has shown a marked improvement toward flattening out the peaks on the charts and an earnest effort is now being made to fill in the low spaces on the chart and thus further reduce the maximum demand. This closer supervision of the rate of steam consumption by the roundhouse has resulted in the maintenance of uniform steam pressure, tube renewals have been practically eliminated and the efficiency of the boilers materially increased. The flow

*See Power Plant Engineering, September 15, 1928, page 998, for description of plant.

meter charts reproduced here were selected because approximately the same total quantity of steam was used during both 24 hr. periods; they illustrate the improvement that has been realized by keeping the roundhouse forces constantly advised of the quantity of steam being used.

Overall Boiler Efficiency Around 80 Per Cent

Average ratio of evaporation now being secured from these boilers shows 1 cu. ft. of 1000 B.t.u. natural gas required to evaporate 0.758 lb. of feedwater at 190 deg. F. into 225 lb. saturated steam. This represents an

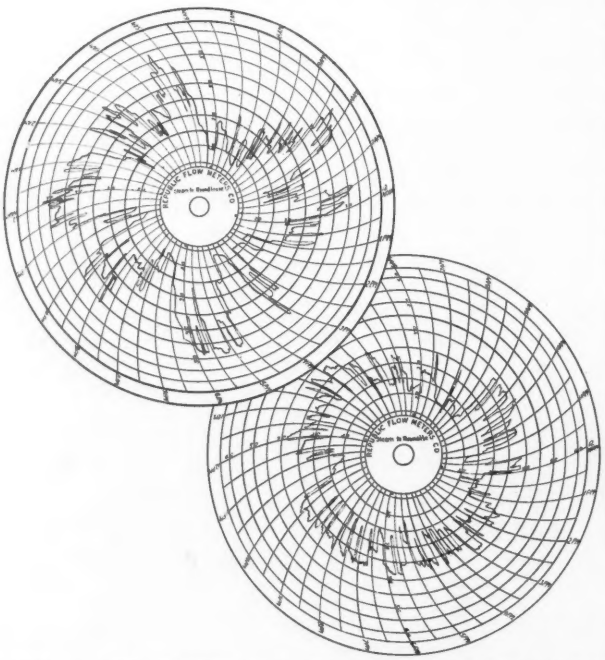


FIG. 2. TWO CHARTS FOR APPROXIMATELY THE SAME TOTAL FLOW SHOWING HOW A FLOW METER INSTALLED IN THE ROUND HOUSE HELPED REDUCE THE BOILER PEAKS. TOP, BEFORE RECORDER WAS INSTALLED. BOTTOM, AFTER RECORDER WAS INSTALLED

overall efficiency of 80 per cent. Raw feedwater supplied to the boilers contains a considerable amount of calcium carbonate which produces a hard scale of low conductivity and resulted in the blistering of several tubes during the initial months of operation. Through the use of boiler compound introduced into the feedwater discharge from the boiler feed pumps, frequent blowing down of the boilers and monthly cleaning of boilers, the injurious effects of scale have been practically eliminated. Approximately 5 per cent of the water fed to the boilers is blown down.

A test was conducted during April, 1929, to ascertain the quantities of fuel and the time required to raise steam pressure to 125 lb. in locomotive boilers by the usual method of burning fuel oil in the locomotive fire box and using steam from the stationary boiler plant for blower stack draft, as compared with supplying steam to the locomotive boiler from the stationary boiler plant by the direct steaming method.

The test developed that an average of 10,700 lb. of steam, at an initial rate of 15,000 lb. per hr. gradually decreasing as pressure in the locomotive and stationary boilers equalized, and 43 min. were required to steam a locomotive with a boiler capacity of 5000 gal. The fuel saved was 20 per cent and the time saved was 35 per cent by the use of direct steaming. The estimated fuel saving per annum is 22 per cent of the investment in direct steaming equipment and installation and the additional boiler capacity required for direct steaming.

Other Savings Harder to Evaluate

There were further savings noted of an indeterminate value such as uniformly heating all parts of the locomotive boiler and fire box water legs, thereby avoiding temperature stresses, increased utility of locomotives and roundhouse and the improved efficiency of the locomotive when dispatched with heated oil in the tender tank and with flues free from the soot and oil sludge which usually accompanies the burning of fuel oil in a locomotive firebox with the inadequate draft secured from stack blowers in a roundhouse.

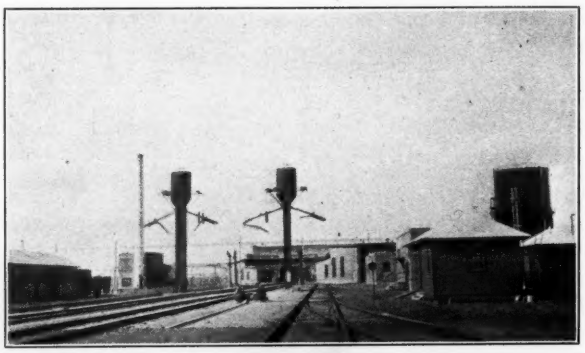


FIG. 3. THE TWO TOWERS TO WHICH SAND IS ELEVATED

Hot water for washing and filling locomotive boilers is supplied to each stall in the roundhouse and circulated, at a pressure of 110 lb. per sq. in., during periods when there is no consumption so as to maintain throughout the roundhouse uniform water temperature. Steam turbine-driven, centrifugal pumps consuming 480 lb. of saturated steam at 225 lb. pressure to deliver 1000 gal. of water are used for this service.

With direct steaming, locomotive fires are extinguished as the inbound locomotive goes on the turntable and are not lighted again until the locomotive leaves the table outbound for train service. As a result, the hazard of fire, always present when fires are lighted inside the house, is entirely eliminated, as is also the cloud of steam and condensation and the deafening sound of steam escaping and wasted through the old stack blower. Absence of smoke and stack gases materially increases the life of overhead piping and structural steel inside the house and eliminates necessity for smoke jacks with corresponding heavier roof construction to carry them. Better lighting is made possible by the use and maintenance of white paint throughout the interior of the roundhouse including the upper walls, rafters, beams and underside of the roof sheathing.

Fuel oil which is unloaded from tank cars by gravity to an underground sump is transferred with duplex piston pumps to storage tanks where it is heated by thermostatically controlled steam coils to 160 deg. F. and flows thence by gravity to the columns where locomotives are supplied. Four hundred and fifty pounds

of steam at 125 lb. pressure is required to pump and heat 1000 gal. of oil ready for delivery to locomotives.

Tests Made to Determine Air Required for Handling Sand

Air for pneumatic tools, testing and air brake charging, locomotive cleaning and elevating sand is compressed to 110 lb. pressure through two stages of compression with compound uniflow engines operating noncondensing and requiring 4 lb. of saturated steam at 225 lb. pressure to compress 100 cu. ft. of free air, as determined by actual test in daily service.

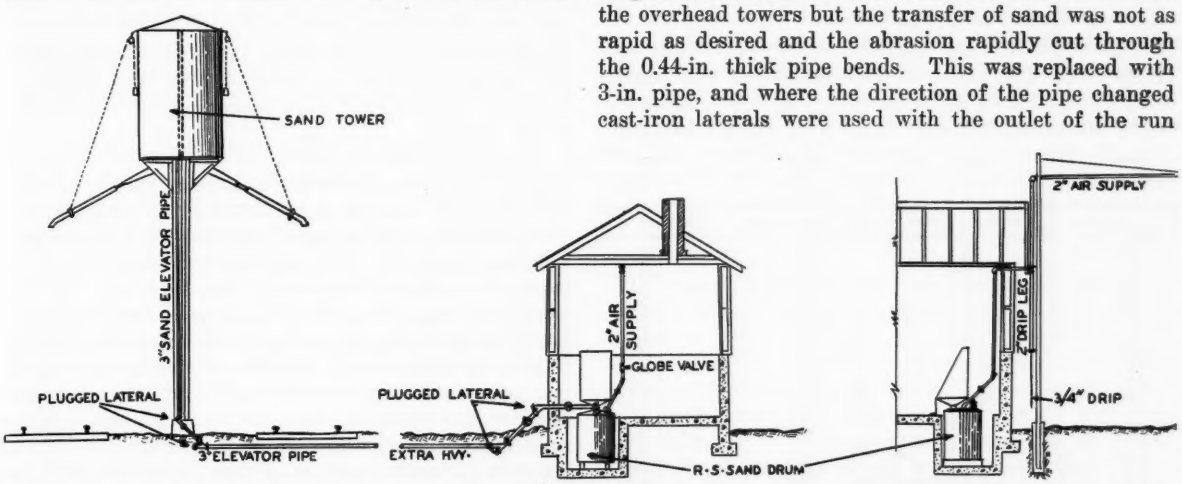


FIG. 4. PIPING AND GENERAL ARRANGEMENT OF THE SAND HOUSE AND TOWER. TESTS SHOW A CONSUMPTION OF ABOUT 10 CU. FT. OF AIR PER CU. FT. OF SAND

TESTS MADE TO DETERMINE THE AMOUNT OF AIR REQUIRED TO CONVEY AND ELEVATE SAND

Sand Transmitted and Elevated To	Quantity of Sand			Time in Minutes	Compressed Air Required		Cu.Ft. Air To Elevate Cu.Ft. of Sand	Cu.Ft. Air To Elevate 1000 lb. of Sand	Cu.Ft. Sand Elevated Per Minute
	10 qt. Bucket	Cu.Ft	Lb.		Cu.Ft. Per Min.	Cu.Ft.			
So.Tower	50	16.71	1750	1.750	102.88	180	10.77	102.8	9.55
No.Tower	50	16.71	1750	1.833	100.82	185	11.07	105.7	9.13
So.Tower	50	16.71	1750	1.666	100.82	168	10.05	96.0	10.06
No.Tower	40	13.37	1400	1.500	100.82	151	11.29	107.1	8.90
Average	47.5	15.875	1662.5	1.687	101.33	171	10.79	102.9	9.41

Extensive inquiry of manufacturers and other railroad lines has failed to produce any record of tests made to determine the quantity of air and the time required to elevate sand to overhead storage towers at engine terminals for gravity delivery to locomotives. In the absence of adequate data, a rule of thumb method seems to have been employed generally heretofore in the installation of this equipment. The results of four typical tests recently conducted at Lancaster Yard Engine Terminal are submitted for the benefit of those who also may have endeavored to secure this information. The quantities of air are at 102 lb. gage and the velocity of the air and sand mixture is around 2200 ft. per min. Average values are given although the amount of air used is a function of the amount of sand handled. For conditions outside of the range given this would have to be considered.

The sand was transmitted through 3-in. pipe from a Rand sand drum having a capacity of 18 cu. ft., to overhead storage towers. Horizontal distance between the drum and the north tower was 95 ft., and the distance to the south tower was 70 ft. The vertical lift from the drum to the towers was 30 ft. Air was supplied to the drum through a 2-in. pipe at 102 lb. per sq. in. pressure. The air was measured with a mechanical flow meter and the dry sand was measured in 10-qt. buckets, net weight of sand 35 lb. per bucket.

Originally, 2-in. double extra strong steel pipe with long radius bends was installed between the drum and the overhead towers but the transfer of sand was not as rapid as desired and the abrasion rapidly cut through the 0.44-in. thick pipe bends. This was replaced with 3-in. pipe, and where the direction of the pipe changed cast-iron laterals were used with the outlet of the run plugged so that a sand cushion was formed at the point where abrasion had destroyed the pipe bends. Nearly 225,000 cu. ft. of sand or an average of ¾ of a car per day has been transmitted since the piping has been changed without any replacement of pipe or fittings and the same quantity of sand is now transferred in 1/5 of the time that was required with the smaller diameter pipe.

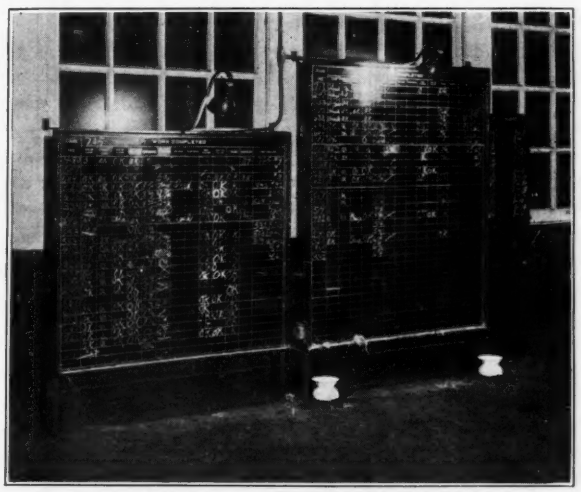


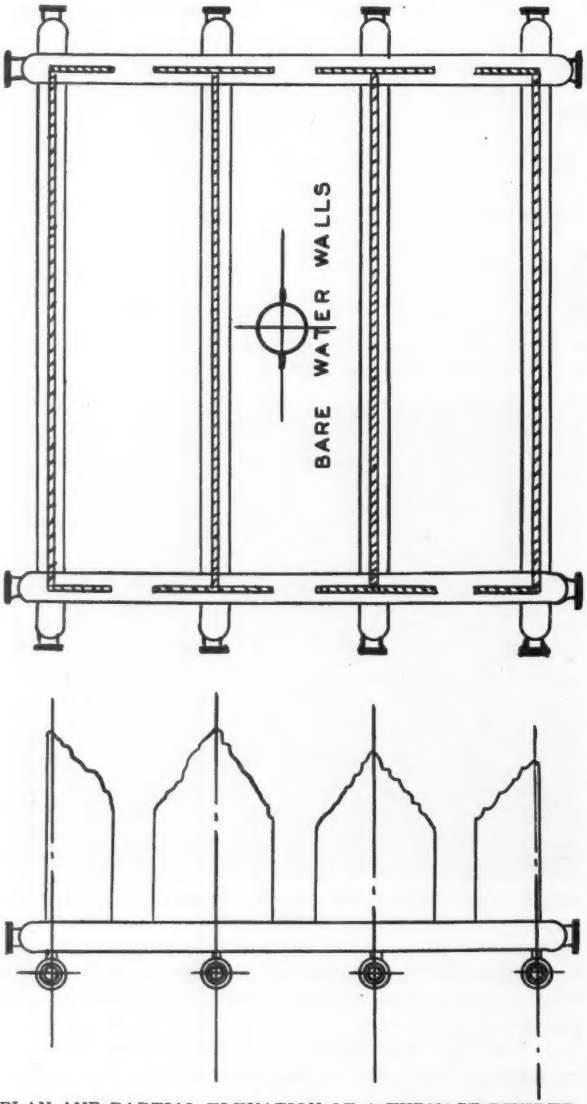
FIG. 5. THE DUPLICATE METER CHART IN THE ENGINEHOUSE

Lancaster Yard boilers, compressors, pumps and the distribution systems for steam, air, fuel oil and hot and cold water are a distinct departure from the installations usually found at engine terminals and the performance of these facilities have justified the increased investment and the attentive engineering necessary to provide them.

Furnaces for Powdered Coal— Should They Be Apartmented?

By Robertson Matthews, Research and Development Engineer, Bolton, Ontario

THE MARGIN OF SUPERIORITY in boiler efficiency and capacity of powdered coal over stoker equipped installations is not yet what its proponents might reasonably expect. In view of the following research findings with coal burned on stationary grates, it would seem that enormous and preëminent rates of heat release should be feasible in powdered coal furnaces when air and gas turbulence are suitably supplied. "The rate of chemical reaction of carbon and oygen is substantially instantaneous; therefore, the rate of combustion must be determined by the rate at which oygen can diffuse through the (gas) film to the surface of the carbon." "It is known that the thickness of the film on the surface of a solid particle (of carbon) is decreased approximately in proportion to the increase in gas velocity."



PLAN AND PARTIAL ELEVATION OF A FURNACE DIVIDED INTO COMPARTMENTS BY WATER WALLS OR SCREENS

Powdered coal is said to be more sensitive to important amounts of smoke than other types of fuel. We also hear that in some installations slagging curtails taking full advantage of the possible high capacity with powdered coal and although powdered coal is already at a disadvantage with the stoker in requiring more involved and sensitive equipment, suggestions are heard for gasifying the coal for boiler use. Such a suggestion would probably not arise if powdered coal performance stood out preëminently in efficiency and capacity for power house operation. These conditions raise the question: Wherein could dividing a furnace into compartments aid in making powdered coal performance preëminent in heat transfer per unit of surface and in fuel efficiency?

It is acknowledged at the outset that the item of dividing a furnace into compartments is but one item of many interrelated items in heat production and heat transfer. It is admitted that perhaps the reason why powdered coal performance does not as yet stand out preëminently, is because of too much consideration of parts and items singly rather than collectively. The steam-making ensemble often suggests an absence, so to speak, of unity of command over the ideas and problems of heat generation and transfer.

How otherwise could we find installations with square yard upon yard of brick walls presented to the most valuable, the most costly heat at the command of engineers, the high temperature heat, and with bulky, sometimes troublesome, economizers added to pick up and transfer a few low-temperature heat units? Were there greater unity of command of ideas in steam making, the problems of the combustion of solid fuel would probably be sufficiently solved to make it a maxim among engineers that the heat to ignite combustible material and support combustion should be supplied by the flame from within itself, with only such aid as the chemist and physicist rather than the bricklayer can provide.

Scotch Marine Boiler Offers Same Problem As Small Water-Cooled Furnaces

From the foregoing, it is evident that this article is intended to apply to furnaces with bare water walls and that it advocates more attention to the phenomena of solid fuel combustion. Further, it stresses the basic engineering fact that the best place to utilize heat is where its temperature is highest. Heat flow through a tube with water and flame at constant temperature should increase about as the available source of heat is increased provided the flow of water is proportionately increased. This last statement means that the pounds of water are like buckets on a conveyor and if the flow at the hopper is free, the conveyed material will be

moved about in proportion to the number of buckets passing the hopper.

To many engineers, advocating division of boiler furnaces would seem a step backward, for the smoke nuisance is still somewhat present. In the present state of the art of burning solid fuel, some advantages claimed for large combustion space are: It helps assure a hot zone for ignition; there is room for mixing of air and combustible gases; it permits long, unchilled flames and a greater time interval for combustion and it affects combustion capacity per unit of furnace volume and the necessary fineness of fuel pulverization.

Length of Flame Travel Is Important

But how are we to explain efficiencies of 81 to 82.2 per cent with hand-fired Scotch marine boilers? The Scotch marine furnace and combustion chamber is not only restricted in comparison with stationary practice but it does not lend itself to much choice in dimensions. Apparently extensive furnace dimensions in all directions are capable both of avoiding and incurring conditions unfavorable to efficient steam making. Overemphasis on a particular item rather than compromise between items seems present in big furnace design. Consider, therefore, a large rectangular furnace divided into three compartments, as in the illustration, formed entirely of bare water walls. The bottoms and the arrangement of the upper tubes, are left to individual choice. Firing can be from each end.

This arrangement of water walls gives the advantages to which the good heat absorbing achievements of the Scotch marine boiler have been commonly attributed; the opportunity for a large amount of heat absorbing surface to "see" incandescent fuel and luminous gases. The arrangement offers more; the short path for heat travel between the center of the flame mass and the heat absorbing surfaces, a condition found in Scotch marine boilers, but about which little, it seems, is being said in discussing operation of the large boiler furnaces at high capacity.

It is unfortunate that in powdered coal furnaces the possible effects at high capacity of the length of the path for heat travel from flame to metal, have not received more attention. This is especially so in view of the relative shortness of the time interval available for heat absorption from the coal when burning solid fuel in suspension compared with the interval when using stokers. The powdered coal furnace may, after a fashion, be considered as stoker fired, the air forming a chain grate with no return mechanism. The fuel feed is light but the grate travels fast and with penalties for tardy combustion. The more excess air the faster the grate travels.

Concerning the item of time available for heat absorption, a contrasting picture may not be amiss at this point. Picture burning solid fuel on grates in a Scotch marine furnace. It resembles, in a measure, the operation of a fuel calorimeter. Were powdered coal furnaces operated like fuel calorimeters with the source of heat remaining adjacent to water walls till all differences in temperature between products of combustion and the water walls disappear, a highly important part of the large problem of heat transfer with powdered coal operation, would disappear, e. g., the problem of available time and of the furnace proportions to promote the best utilization of the seeing capacity of the radiant heat absorbing surfaces.

Walls Screened from Heat

It might be thought that since the incandescent particles of coal are radiating heat at the speed of light their time of passage might be sufficient for them to give up most of their available radiant heat. But there can be considerable interference to heat transfer between these radiant substances and the water walls. The heat intercepting influence of a clouded sky and smoke screen, is so familiar in most cities as to receive little pondering. That a like influence may occur in boiler furnaces, deserves more practical consideration than it seems to be obtaining; the more so since, though it may admit of theoretical analysis, the operating conditions surrounding this influence are too complex to permit calculating its effects.

Of course it may be declared that the temperature within a furnace and the temperatures near the earth's surface are not comparable conditions in referring to smoke screen effects; that, since radiant heat is transmitted as the fourth power of the absolute temperature, the high-temperature radiant heat in a furnace will break through a smoke screen because of the sheer intensity and quantity of the energy released.

The fact remains, however, that all bodies that receive radiant energy also radiate it and in all directions. Instead, then, of a core of hot material at the center of the furnace being able by sheer intensity and quantity of heat to drive its heat through a screen of gases, of ashes or of solid fuel, a part of this heat energy is going to be radiated back upon its source by this screen. A reverberation of radiant heat can occur, beating back and forth between screens or banks of radiating particles and, in part, of gases. The intensity of this reverberation will diminish towards the water walls in so far as the screens of radiant matter can in turn bombard, with heat, the water walls or other bodies having greater capacity than the screens for absorbing heat energy.

Experiments Must Be Resorted to in Order to Obtain the Necessary Information

A question at once arises: If such a screen is considered to be made up of a layer of matter capable of absorbing and radiating heat and with this matter for the moment stationary, what is the permissible depth of such a screen before it will interfere appreciably with useful heat delivery from the center of the flame? In short, how wide may a furnace be made before meeting appreciable opposition of this sort to heat transfer to the tubes? The problem is complex. The answer is to be found by tests.

One basic reason why the best width for a furnace can not be determined on paper, is that the substances forming the screens do not remain quiescent nor travel for long in straight lines. In large powdered coal furnaces, distinct portions of the flame mass can be seen side stepping several feet with great speed. This turbulence is not highly amenable to any attempts at mathematical calculation of heat transfer.

Two states or locations of turbulence call for separate attention. The turbulence that insures complete combustion may be a local condition in the region of the nozzle. But the turbulence that is essential, because

of screens, to bring the gases and flames so that their heat may be within striking distance of the heat abstracting tubes, is a larger or general turbulence.

Control of general turbulence throughout a large furnace and a high degree of success in attaining directed general turbulence are likely to be disturbed by irregularities in the flame movement incidental to a mixture of air and solid fuel particles not giving the uniformity of mixture possible with liquid fuels. Flame pulsations, however, may thus be set up that will cause beneficial surging of the gases and the reduction of isolated flame cores.

If, however, the furnace is of great volume, these displacements will be only local since flames fed by fuel supplied near the boundary of the furnace will tend to restrict the sidewise movement of flames fed by fuel supplied for the middle of the furnace. Increase in width of furnace, that is, in number of burners, can, therefore, create screens against the transfer of heat to the side water walls from fuel burned near the middle of the furnace. Sufficient general turbulence, in such a case, to insure against some flames blanketing portions of other flames from the heat absorbing metal, might cause gas surges of disturbing magnitude and also the too early escape from the furnace of some combustible.

Carbon Particles Form Effective Heat Screen

To return to a general consideration of the allowable thickness of a screen of flame and gases, some approximate calculations respecting the density of the screen, that is, of the mixture of gases and solids in the flame body, may show that this density, because of its apparent insignificance, may easily be misleading. For example, with heat liberation of from 25,000 to 35,000 B.t.u. per cu. ft. per hr. there will be fed coal at the rate of around 2 lb. for each cubic foot of furnace volume. In reality, during combustion this coal will be distributed throughout the volume of a total of about 24 lb. or more of air having a possible temperature of 2400 deg. F. while contributing to the flame body. At this temperature and at approximately atmospheric pressure, the specific volume of the air would be about 72 cu. ft. per lb. This amounts to about 865 cu. ft. of hot air per pound of coal. Considering the amount of solids per pound of coal at the instant of coking but before the combustion of the solids, as 0.7 lb., and taking the density of this coke at 75 lb. per cu. ft., gives a weight of solids per cu. ft. of hot air as only 0.0093 lb.

Were these solids per cu. ft. compressed to a single layer, the thickness of which would be comparable only with paper in fact, adding together 5 to 10 of these layers would still leave a thickness comparable with paper. Such a screen, even with the heat absorbing and radiating capacity of CO_2 and H_2O also present, does not at first thought seem formidable.

Regarding the influence as a screen of solid carbon in suspension, however, it is worth noting that in an experimental electric arc furnace using carbons nearly 2½ in. in diameter and with water-cooled copper coils less than 9 in. from three arcs, the presence of an incandescent cloud of lampblack, as light a form of solid as is to be met with in commercial furnaces, lowered the temperature rise of the water, entering, at around 46 deg. F., from 44 to 32 deg. Now, the temperature of those arcs was probably between two and two and one-half times that of flames prevailing in powdered coal furnaces under heavy load. We are told that the rate of heat transfer varies at least as the fourth power of the absolute temperatures.

Regarding the blanketing effect of a wall of luminous flame from coal gas as fuel, Professor R. Royds has made the following deduction from experiments by Callendar:

". . . there was no attempt made to measure the temperature of the flame in these experiments and it is likely that the temperature of the flame would rise with the number of burners. In any case, it is seen from the foregoing results that the radiation from a flame of, say, 2 ft. depth would be practically equal to that from a similar flame of great depth."

In the foregoing flame experiments, six Meeker burners, all alike, were placed in line with flame touching and with such a ratio of air to coal gas as to give a luminous inner core in the flames.

It would seem, therefore, that if the side walls of a powdered coal furnace are to do their best in absorbing their share of the heat load, they should be but a moderate distance apart, the best distance for a given load being determinable only by test. In this connection, the expression "rate of energy release" falls short as a comparator for design.

For furnace design, the expression "rate of energy release" does not reveal the decisive value of the time element in the combustion of powdered coal. The rate of firing for two cases might be the same but the rate of combustion widely different. Hence the "rate of energy release" in terms of pounds of coal per hour, might be constant but the flame temperatures be different. Thus if a given quantity of powdered coal takes four seconds for complete combustion, the temperature rise of the gases would not be as great as if combustion were complete in one second.

Forced Circulation Might Be Advisable

The apartmented furnace presents other items besides that of radiation screens. To obtain economy of ground space a transverse section such as shown would be favorable. As regards dollar efficiency, the inner walls as shown would have their heat absorbing capacity utilized on both sides, which would mean a reduction in cost per square foot of their heating surface compared with outer water walls. Concerning boiler efficiency at different loads, it might be possible to design a unit to permit loading individual apartments differently and in a manner to give the best efficiency for the unit. Regarding tube failures, with these already occurring in tubes receiving heat on one side only, all round exposure to high-load heating may seem rash. But the more uniform heating of the tube should not be a disadvantage as regards stresses; and the danger from steam bubbles tarrying on the walls should not be increased since the rate of circulation and possibly its regularity would be increased.

If necessary, forced circulation could be resorted to in order to increase the weight of water circulated and hence the heat abstracting capacity of the tubes; a boiler with high performance characteristics should be as much entitled to some mechanical manipulation as the furnace, at least once that point of view obtains.

With water walls in close proximity to the flame mass

at all times, there would be little likelihood of ash being segregated within a reverberatory mass of flame and unable for an appreciable time to radiate its heat to the metal walls. Of course it is not known how long an interval of time might be required to fuse small particles of ash. But even allowing fusion has occurred, an aggregation of slag should be diminished if the time interval available for holding the ash in a fused condition is reduced.

Efforts to utilize instead of to avoid slagging should suggest further development of short flame combustion for high capacity. Tangential feed of powdered coal seems to hold the record for furnace capacity. But at least one report tells of slagging defeating the expected capacity. It is possible that there, because of increased density of the radiating screens, is a case of a central core of gases and solids radiating back and forth among themselves and upon the enclosed ash for too long an interval. It may be difficult for air fed from the sides into a vertical whorl of gases and solids to reach the innermost combustible in the most effective condition to speed combustion and clarify the flame mass of combustible solids.

For example: The combustion of carbon monoxide is supposed to follow the chemical path not of

$$2CO + O_2 = 2CO_2$$

but of $CO + H_2O = CO_2 + H_2$

and then $2H_2 + O_2 = 2H_2O$

Now with air fed from the sides and kept at a minimum, how much of its moisture will be available as a catalyst for combustion at the core of the flame mass after passing through screens or banks of burning C and CO? If at the center of the whorl there is an absence of sufficient catalytic moisture, the combustion of the fuel there will be greatly retarded.

As regards a choice between apartmented furnaces and single large furnaces, a large combustion space as a cure-all for the primitive state of the art of burning solid fuel is sure to have its price.

Turbine Capacity in Railroad Repair Shops

IN COMMON WITH OTHER INDUSTRIES, LARGER UNITS AND INCREASED POWER CONSUMPTION ARE SHOWN BY SURVEY OF PRIME MOVERS IN THIS FIELD

EVIDENCE, typical of the increasing appreciation of the use and value of power in industry, is furnished by the figures for prime movers installed in steam railroad repair shops of the United States.

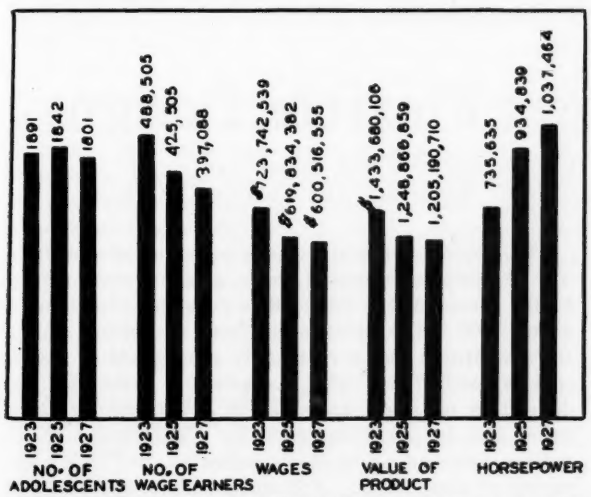


FIG. 1. IN SPITE OF A 16 PER CENT REDUCTION IN THE VALUE OF PRODUCTS THE POWER CONSUMPTION OF STEAM RAILROAD REPAIR SHOPS SHOWS AN INCREASE OF 41 PER CENT IN FOUR YEARS

Relative values of the different factors for three years are shown by the chart Fig. 1. During this period, the number of establishments reporting remained nearly the same but the value of the products or output decreased 15.9 per cent from 1923 to 1927. During the same period, the number of wage earners decreased 18.7 per cent while the amount of wages decreased only 17 per cent, indicating a higher individual wage scale. It is interesting to note that labor accounts for approximately half of the value of the product.

In spite of the decreasing output, the installed power increased from 735,635 hp. in 1923 to 1,037,464 hp. in 1927, an increase of about 41 per cent. Considered on the basis of output, valued in dollars, the power increase was approximately 68 per cent; that is, about 860 installed hp. was used for every million dollars in output in 1927 against about 512 installed hp. in 1923.

TABULATION OF PRIME MOVERS AS REPORTED BY THE DEPARTMENT OF COMMERCE

TYPE	1927		1923	
	Number	Capacity	Number	Capacity
Prime movers, total	39,998	*Horsepower* 1,037,464	[1] 32,637	*Horsepower* [1] 934,839
Steam engines	1,861	282,242	1,890	286,215
Steam turbines	205	146,839	[1] 170	[1] 129,334
Internal-combustion engines	142	6,460	142	4,643
Water wheels and turbines	4	482	3	32
Electric motors driven by purchased current	37,786	601,441	30,432	514,615
Electric motors, total	55,830	865,730	47,180	775,553
Driven by purchased current	37,786	601,441	30,432	514,615
Driven by current generated in establishment reporting	18,044	264,289	16,748	260,938
Electric generators	729	*Kilowatts* 172,310	882	*Kilowatts* 142,451

Tabulated data for 1925 and 1927 is shown in table. The same data are presented graphically in Fig. 2. Steam turbines, steam engines and electric motors driven by current generated in the plant show small changes but the increase in use of motors driven by purchased current and electric generators is the most noticeable. Internal combustion engines and water wheels play a relatively small part in this industry.

Average sizes of the different units are shown in Fig. 3. Electric motors average around 16 hp. and show little change from year to year. Internal combustion engines are increasing slowly in size but average close to 50 hp. each. Steam engines range around 155 hp. and steam turbines between 700 and 800 hp. The average of

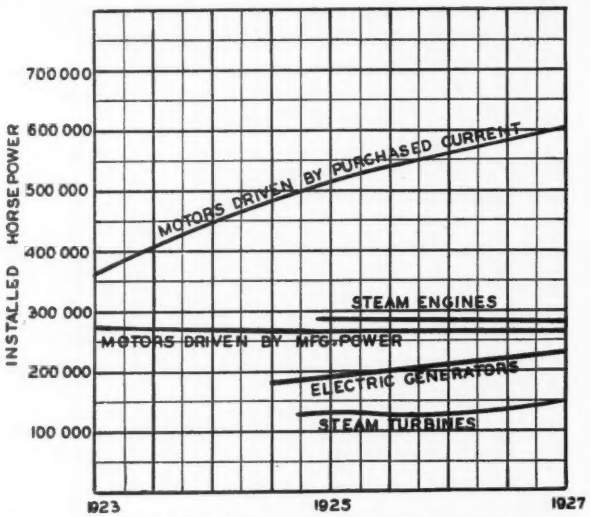


FIG. 2. MOTORS DRIVEN BY PURCHASED POWER SHOW THE GREATEST GAIN

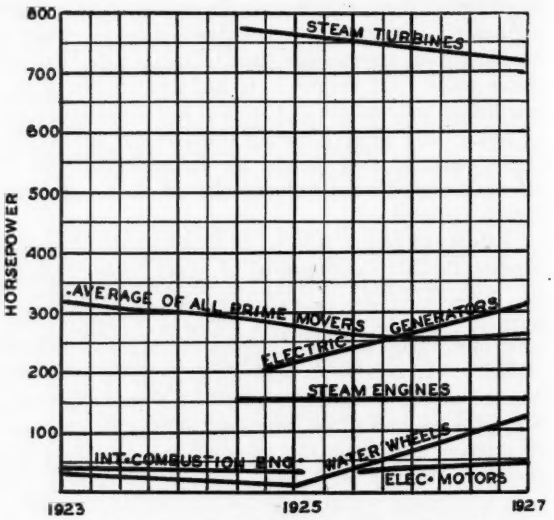


FIG. 3. AVERAGE SIZE OF UNITS

all prime movers is decreasing, probably due to the tendency toward individual drive which is common to all industries.

The two years from 1925 to 1927 show an increase of 76,826 hp. in motors operated by purchased power against an increase of but 3351 hp. for motors operated by current generated in the plant. There is, however, an increase of 29,959 kw. or over 40,000 hp. in electrical generators. As the increase for steam turbines, internal combustion engines and water wheels is but 19,772 hp., the unusual increase in electrical generators must be due to the conversion from mechanical drive to electrical drive.

Repair shops are maintained by steam railroads for the purpose of making repairs on rolling stock and bridges, work classified as car and general construction and repairs. This does not cover the operation of roundhouses where incidental repairs are made but no machine shop work is performed. Locomotives and cars, particularly the latter, are built to some extent in repair shops but the bulk of the work consists of repairing and rebuilding.

Pulverized Coal Allows Flexible Design

WIDE CHOICE IS ALLOWED DESIGNER IN PLANT ARRANGEMENT BUT BOTH COAL TO BE USED AND FURNACE DESIGN SHOULD RECEIVE CAREFUL ATTENTION. BY OLLISON CRAIG*

THERE ARE TWO distinct types of systems for firing pulverized fuel; one is referred to as the Storage or Bin system and the other as the Unit or Direct Firing system. In the storage system, raw coal is pulverized and stored in bins, whence it is withdrawn as required. The complexity of this system depends on individual design. There may be one point of storage or there may be two. In case of only one, pulverized coal is fired from the bin in which it is stored immediately after pulverization. In most cases, the coal is pulverized, separated and stored in bins, then transported to one or more bins at points of use, whence it is withdrawn for use. In contrast to this, unit pulverizers receive new coal, pulverize it and discharge it directly to the furnace in which it is to be burned.

Mechanical equipment of a unit pulverizer system, consisting of pulverizer, pulverizer drive, burner, connecting coal pipe, forced draft fan and fan drive can be installed in most localities at a cost equivalent to $5 per developed boiler horsepower provided a fair grade of eastern coal, running about 13,500 B.t.u. per lb., is used.

*Consulting Engr., Riley Stoker Corp., Worcester, Mass. Abstract of a paper presented before the Boston section of the A. S. M. E. and the Associated Engineering Societies of Boston.

To amplify this statement, a boiler rated at 600 hp. can be equipped as stated above, at a net cost of about $7500, provided it is intended to develop a maximum of about 1500 boiler horsepower from the boiler and on the assumption that a reasonably good grade of eastern coal is used. There will be variations from this cost depending on location, character of fuel and ratio of boiler size to pulverizer capacity. The figure of five dollars, however, on the basis indicated, will give a fair means of comparison. For small boilers, the cost may be considerably higher, but for high capacity, high efficiency units the cost will be less.

WESTERN COALS MORE ABRASIVE THAN EASTERN

With lower grade coals, the cost will be greater since more pulverizing capacity must needs be installed for a given steam making capacity. Maintenance costs for a given installation are more directly dependent on coal characteristics than upon any other factor. There is a wide range of abrasiveness in coals, consequently a wide range in rate of wear of pulverizer parts. An average installation using a coal similar to New River or Pocahontas should experience a cost for renewal parts of from 2 to 3 cents per ton of coal pulverized. For West-

ern Pennsylvania or Eastern Kentucky coal, the cost may vary from 3 to 5 cents per ton, while in more abrasive coal such as Illinois the cost may be from 5 to 8 cents per ton.

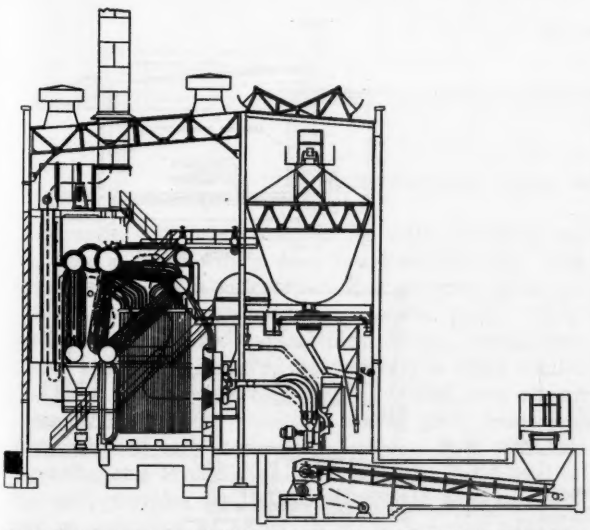
Loss of combustible matter depends on character of coal, furnace design, burner design and control of operations. With pulverized fuel firing, unburned combustible matter consists almost entirely of fixed carbon. It is rarely that carbon monoxide or hydrocarbons are found in the gases leaving the boiler.

Certain coals burn more freely in powdered form than others. For example, it is possible to get less loss due to unburned carbon with Illinois coal than with Pittsburgh district coal, although the percentage of actual ash may be considerably greater. In general, firing coal in pulverized form results in less carbon loss than by any method of firing on grates.

Furnace design can affect carbon loss through size, shape and character of walls. Larger furnaces for a given rate of burning permit more time for completion of combustion. The shape of the furnace may be such as to make the volume of greater or less availability. Other conditions being the same, the colder the furnace walls the greater the carbon loss. With regard to wall design, other factors are of such greater importance in most cases that these factors in general dictate the wall design. Other losses entering into determination of efficiency, such as gas temperatures and radiation, are subject to boiler and setting design rather than the fuel burning equipment.

High Efficiency Maintained Over Wide Range

It is possible with the best underfeed stoker, with the most adaptable coal, operated under best conditions to equal efficiency obtained with best pulverized coal equipment burning the most adaptable coal and operated under the best conditions. Particular rate of burning is included under best conditions. Efficiencies obtained in long time operation, however, will in general be quite different as between the two methods of firing and while the same efficiencies may be obtained by each method of firing at certain points of operation, the efficiency curves will tend to spread apart at both high and low ratings.



CROSS SECTION OF THE BOILER PLANT FOR THE ABERFOYLE MANUFACTURING CO., CHESTER, PA.

The accompanying illustration shows an installation designed for maximum efficiency. The convection portion is a 750-hp. boiler and the furnace contains water tubes on each side wall, on the rear wall and on the front wall above the burners. There is also an integral economizer and an air preheater. The unit is capable of developing 4000 boiler horsepower continuously. It is also possible to operate at 360 b.hp. continuous firing, using both burners. Tests on these units have shown over 90 per cent efficiency throughout the range from 1700 to 2900 b.hp.

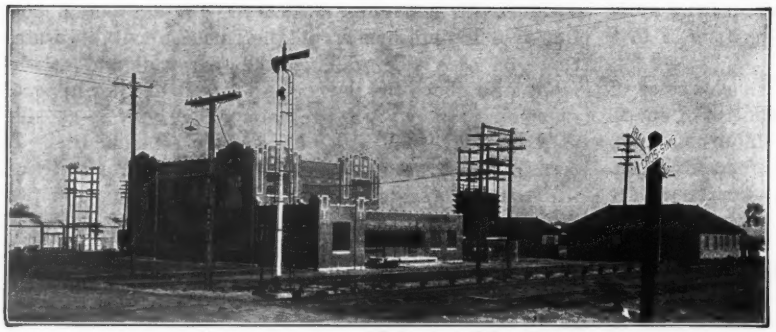
Engineering Foundation, Inc. Succeeds United Engineering Society

Engineering Foundation, Inc., successor to United Engineering Society by change of name only, is a non-profit, membership corporation whose charter gives it broad powers for the advancement of the engineering arts and sciences. It was set up by four national societies, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, which therefore came to be known as the Founder Societies.

Objections had been voiced from time to time to the name United Engineering Society and experience for many years had demonstrated that this name caused confusion, misconceptions and other difficulties. The organization is not a society in the usual conception of the word. It is a corporation administering real estate, funds and a library, for scientific, educational and other purposes beneficial to the public through the engineering profession and the related sciences and industries. Its functions correspond closely to those of corporations of universities and of foundations for scientific, social or economic research. It is truly a foundation; the name Engineering Foundation is appropriate. Therefore, with the approval of the Founder Societies its name was changed beginning January 1, 1930.

United States Civil Service Commission announces open competitive examination for Engineering Aide. Applications for this must be on file with the Civil Service Commission at Washington, D. C., not later than March 4. The examination is to fill vacancies in the Interstate Commerce Commission and in positions requiring similar qualifications, for duty in Washington, D. C., or in the field. The entrance salary is $1800 a year. Higher-salaried positions are filled through promotion. The duties are to make calculations of land areas or the computation of grading, track and other items of property from field notes, and the collection of these for pricing, and related work as required. Competitors will be rated on general physics, mathematics through analytic geometry, and on practical questions on elementary engineering. Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or the Secretary of the U. S. Civil Service Board of Examiners at the post office or customhouse in any city.

Power factor of a plant can often be raised by rearranging the motors so that they are all fully loaded.



DIESEL PLANT CONSTRUCTED in 3½ MONTHS

WHITEWRIGHT, TEXAS STATION, LATEST ADDITION TO CHAIN OF TEXAS-LOUISIANA POWER CO. DIESEL ENGINE PLANTS, IN OPERATION 3½ MONTHS AFTER BREAKING GROUND

RAPIDITY WITH WHICH it is possible to erect a Diesel power plant and install all of its equipment is a quality that is inherent in this type of plant. Especially is shortness of time valuable in central station practice in situations such as in western and southwestern localities where sudden rapid increase in growth of a town or group of towns often severely taxes available power sources.

Eleven towns in the vicinity of Whitewright, Texas, which had been served with electric power from remote sources by the Texas-Louisiana Power Co., had grown to such proportions that increase of available power was urgent. It was desirable also to effect fundamental economies in electrical distribution. Under the direction of F. A. Burdick, chief engineer of this company, work was started on the Whitewright Diesel power plant on

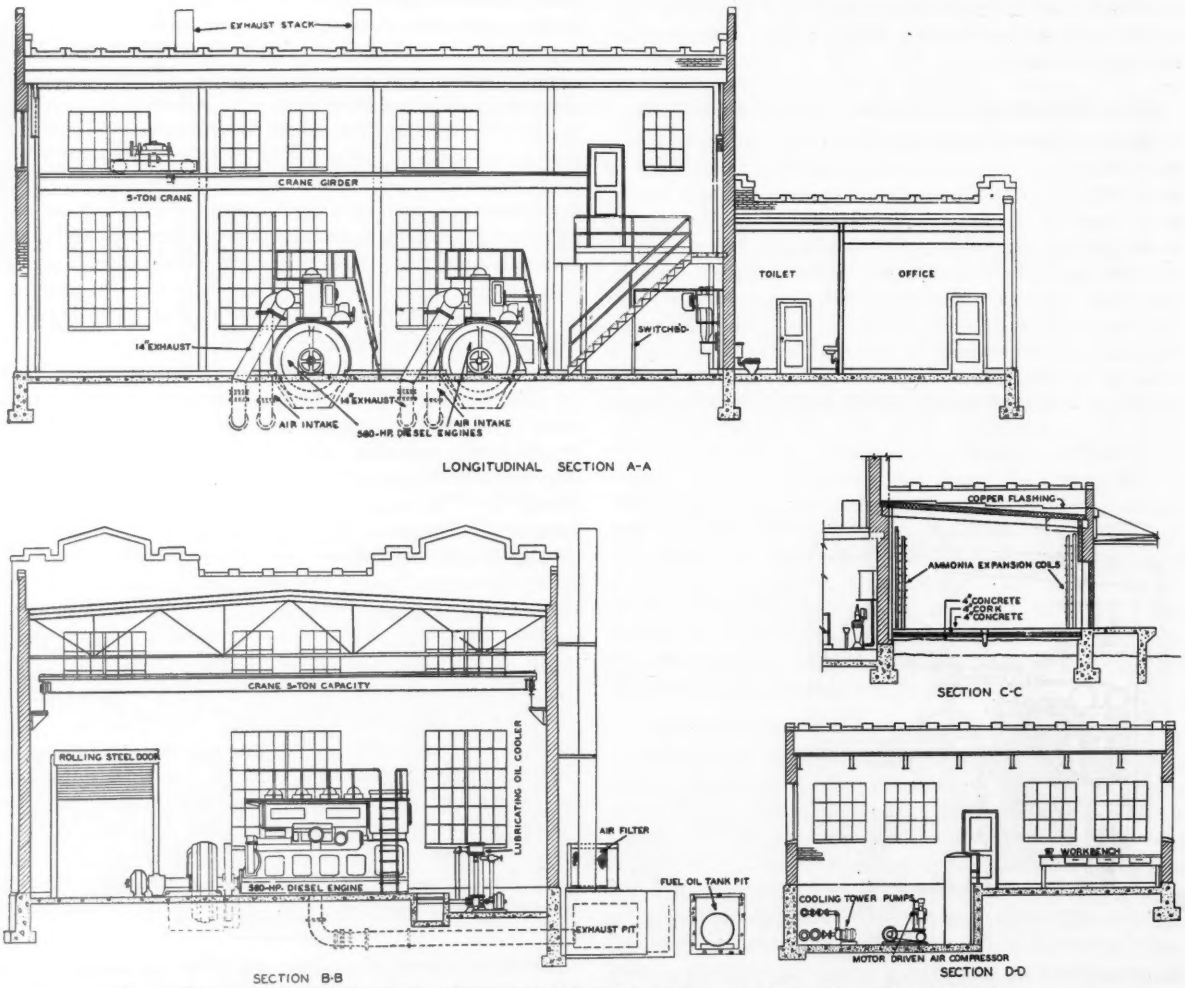


FIG. 1. ELEVATIONS SHOWING RELATION OF THE VARIOUS EQUIPMENT UNITS

Sept. 14, 1928, and the plant was put in operation on Jan. 1, 1929, assuming its burden strictly on scheduled time.

Since the plant started, it has been operating on continuous service. Energy is supplied to the eleven towns through a network of 22-kv. and 6600-v. transmission lines. With the two 385-kw. generators installed at the time, the plant carried a 60-minute peak load of 800 kw. before the additional unit was installed. The average load at that time, however, did not exceed 250 kw. The plant load factor under these conditions is 31.3. With the three units, the annual net station output is estimated to be 1,265,600 kw-hr. and the average net daily output 4300 kw-hr. with 75 kw. as the corresponding daily house load.

storage tanks, wiper oil tank, refrigerating machine and for a small work shop. The roof is of fireproof construction, consisting of structural steel supporting members, holorib, steel decking, one inch of Celotex insulation and standard 3-ply asbestos-felt built-up waterproof covering. No basement has been provided; the section in which the circulating water pumps are located, however, is 5 ft. below the main floor level.

Same Oil Used for Piston Cooling and Machine Lubrication

Piston cooling and lubrication of all parts of the engines are accomplished by the same lubricant. The Diesel engine medium oil which is used has a gravity of

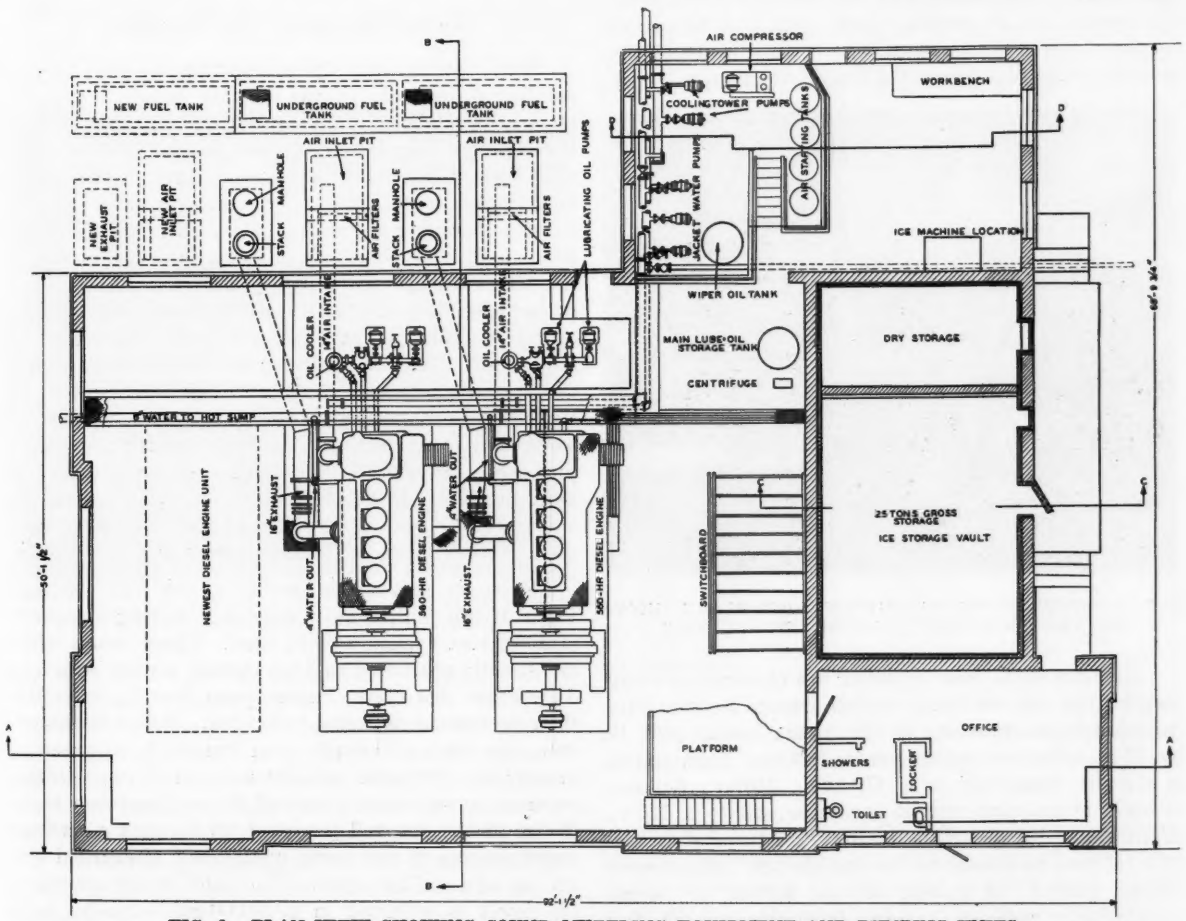


FIG. 2. PLAN VIEW SHOWING SOUND MUFFLING EQUIPMENT AND PUMPING UNITS

Framed with steel and having walls of brick, the building is faced with a deep rough-texture face brick and trimmed with cut stone. The interior walls are finished with two coats of light cement paint. Originally, only two Fairbanks-Morse 560-hp. engine-generator units were installed but recently a third similar unit, for which space had been provided, was added. Foundations for the machines are of plain mass concrete without reinforcement. A 50 by 26-ft. building extension at a level 21 in. below the main floor level on one end, provides for the office and cold storage vaults and an extension of 19 by 36 ft. in the rear provides space for the circulating pumps, air compressor, air

26 to 27, a flash test of from 400 to 410 deg., a fire test of from 470 to 480 deg. and a viscosity of 300 at 100 deg. During the first eight months of its operation, the lubricating oil economy averaged 3290 kw-hr. per gal. Thus far no difficulty has been experienced with carbonization within the cylinders and no piston rings have stuck.

Handling facilities have been provided for by the installation of a hand-operated Chisholm-Moore traveling crane having a main hoist of 5-t. capacity for handling heavy parts and an auxiliary hoist of 1-t. capacity for handling cylinder heads. The crane runway is sup-

ported on steel brackets attached directly to the building columns.

Refrigeration Is Part of Service

Cold storage rooms were provided to supply local needs. Refrigeration is accomplished by a small Sterling self-contained ammonia compressor through a direct-expansion system. A steel balcony with concrete floor slab was installed over the switchboard for protection of the board, for mounting the generator field rheostats, for location of the auxiliary power distribution panels and cabinet and for additional storage space.

Switchboard equipment designed and installed by the Westinghouse Electric & Mfg. Co. consists of three generator panels, one swinging bracket, one regulator panel, five feeder panels and one station service panel. All panels are of natural black slate and oil circuit breakers are of the manually remote control type mounted some distance in the rear of the panels.

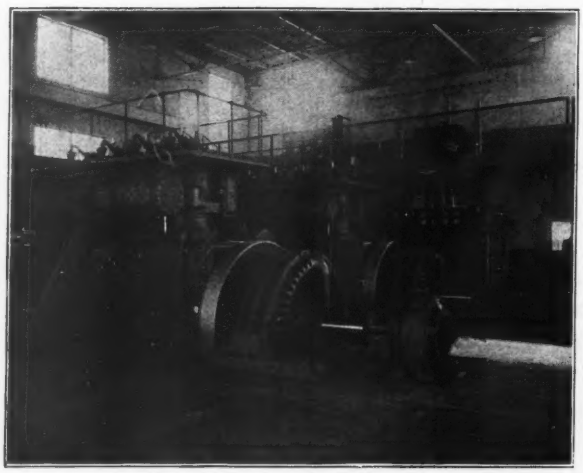


FIG. 3. ENGINE ROOM OF WHITEWRIGHT PLANT SHOWING THE TWO UNITS OF FIRST INSTALLATION

All three units, now installed, are identical in every respect, the engines being of full Diesel, 2-cycle, solid injection type, operating at 257 r.p.m., having four 16 by 20-in. cylinders and delivering 560 hp. Each engine is directly connected to a 470-kv-a., 2400-v., 3-phase, 60-cycle alternating-current generator and to a 125-v., shuntwound direct-current exciter. Features of particular interest in regard to the engines are built-in scavenging pumps, oil cooling of the pistons by forced circulation, a complete pressure-lubricating system and motor-driven synchronizers. Brown pyrometers for indicating individual cylinder exhaust and Bristol two-pen recording thermometers for registering the in and out temperatures of the jacket-cooling water are provided for each engine.

Unusual Air Intake Construction

Each engine is provided with an independent air intake composed of twelve 20 by 20-in. sections of Reed multi-cellular air filter which, in each case, is mounted in a steel frame resting on an air intake muffler chamber located adjacent to the exhaust expansion chambers outside of the building. The air passes from the muffler chamber through a pipe below the floor line to the suction of the scavenging pump. While noise was eliminated due to the large size of the intake muffler chamber and of the intake filters and vibration due to the air intake considerably reduced, it was found necessary to choke the connection between the filters and the concrete chamber in order to eliminate vibration trouble from this source.

Instead of employing the usual type of exhaust muffler, the exhausts of each engine are carried independently below the floor line to plain rectangular concrete expansion chambers outside of and to the rear of the building. Gases are discharged from the expansion chambers through vertical stacks which are carried to a point a few feet above the top of the building.

Water Treatment Not Necessary

Water for cooling the lubricating oil and for circulating through the engine cylinder jackets is supplied from an open-type circulating system. In order to avoid trouble due to formation of steam and air pockets in the pipe lines where water is handled through the engine and over the cooling tower by means of a single pump, a double pumping system was installed. Since the water must be discharged under pressure from the engine in the single pump system, it is also harder to obtain proper distribution of the water through the different cylinders. The double system provides excellent distribution. Although nonencrusting solids amounting to 650 p.p.m. are found in Whitewright city water, the total hardness amounts to only 44 p.p.m., hence the water is of a particularly desirable quality for cooling purposes. No evidence of scaling in the jackets has been observed. For these reasons, the open system was adopted. A 4-in. Golden Anderson automatic water inlet valve is provided for emergency use.

Water for each unit is handled by two Allis-Chalmers motor-driven centrifugal pumps each having a capacity of 200 g.p.m. against a 60-ft. head. These pumps which are directly connected to 5-hp. motors, are set on a level 5 ft. below that of the engine room floor in order that their suctions always may be flooded. Water discharged from the engines through open funnels is returned by gravity to a 6000-gal. capacity hot well which is located adjacent to and made a part of the cooling tower basin. Water in the hot well is picked up through a screened outlet by one of two tower pumps and discharged over the top of a cooling tower. The cooled water coming off the tower is collected in a 10,000-gal. capacity basin directly below the tower and from there passes through a screened intake to the suction of one of the jacket water pumps which forces the water through a Schutte & Koerting, shell and tube type lubricating oil cooler, thence to the engine cylinder jackets into which it enters at an average temperature of 80 deg. F. and leaves the engine at 115 deg.

The cooling tower, which is built of California redwood, is of the wide louver type. Its dimensions are 8 ft. by 18 ft. long and 30 ft. high and it is designed to handle 300 g.p.m. through a temperature range from 115 deg. to 85 deg. F. with wet bulb temperature of 75 deg. and wind velocity at 5 m.p.h. In operation, the water temperatures vary considerably due, to some ex-

tent, to variations of wet bulb temperature and to a larger extent, to variation in wind velocity.

Lubricating System

Each engine is supplied with duplicate 100-g.p.m. Geo. D. Roper Corp. rotary type lubricating oil circulating pumps operating under a 40-lb. per sq. in. head. Oil is taken from the base of the engine and forced through the shell and tube cooler and an Andale Engineering Co. twin strainer before it reaches the pistons and bearings. A Sharples centrifuge having a capacity of from 35 to 125 g.p.h. and driven by a 1-hp. motor is used for oil reclamation.

Provision has been made for draining all of the oil in the engines into a "wiper oil tank," located on the circulating pump floor level, when it is found desirable to make a change. All oil wiped from the cylinder walls is drained externally and carried off through a

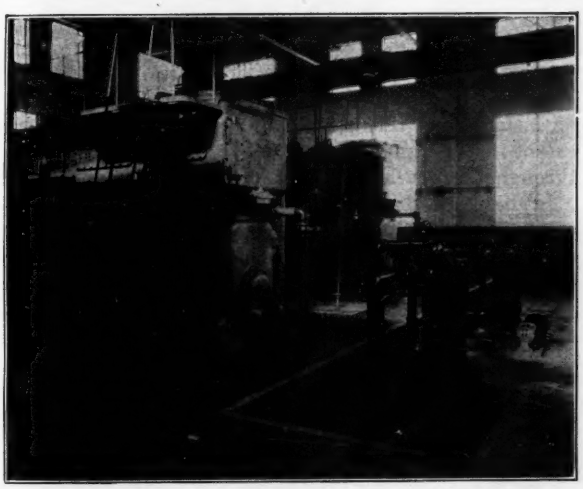


FIG. 4. VIEW OF ENGINE ROOM SHOWING HOW LUBRICATING OIL PUMPS ARE INSTALLED

pipe to this tank for accumulation. Another tank of about 1000-gal. capacity known as the clean oil storage tank, has been located on the engine room floor adjacent to the centrifuge. Dirty oil is pumped from the wiper oil tank through a heater into the centrifuge, a small batch tank being located midway in the piping in order to effect regulation of the flow to the centrifuge. Clean oil from the centrifuge is pumped into the clean oil storage tank from which it can be fed as needed by gravity to the engines.

All new lubricating oil delivered to the plant is unloaded and stored in drums in an oil house located about 50 ft. to the rear of the power house. When new oil is required in the engine room, it is transferred from the oil house by means of a hand-operated rotary pump, through a delivery line to the clean oil storage tank thus handling of drums inside of the engine room is avoided. The oil heater is one designed by the engineers of the Texas-Louisiana Power Co. and consists of a coiled pipe inside of a cylindrical container which is filled with water which, in turn, is heated by means of one or two 5-kw. bayonet-type electric heaters. The oil passes from top to bottom through the coiled pipe. In this style of heater the oil does not come in contact with excessively high temperatures, hence no difficulty is experience with carbonization. The heater is set directly above the centrifuge. Best results in the centrifuging process are obtained when the temperature of the oil is raised to from 140 to 180 deg. F.

Fuel oil of 24 to 26 Baumé gravity and 143,000 B.t.u. per gal. heating value is used. It is brought to the plant in tank cars which are spotted for unloading, on a railroad siding adjacent to the power house. Unloading is accomplished by means of a Viking type ZK rotary pump rated at 450 g.p.m. against 100-ft. head and operating at 450 r.p.m. This pump is driven through gearing by a 2-hp. motor. Two 10,000-gal. steel tanks located above ground are provided for fuel storage. A Heat Transfer Products Co. shell and tube type heater 19½ in. diameter by 13 ft. long and having 100 sq. ft. of heating surface, is installed at the storage tanks for warming the fuel during cold weather. Heat is supplied by cylinder jacket water which is piped to it.

Two air compressors have been installed for supplying starting air at 250 lb. per sq. in. press. The first, which is usually used, is a 4½ and 2 by 4½-in. Gardner-Rix twin-cylinder compressor which has a rated capacity of 21 cu. ft. per min. at 300 lb. press. and operating at 400 r.p.m. This is belted to a 7½-hp. electric motor. The auxiliary unit is a 3¾ by 3⅜-in. Fairbanks-Morse compressor which operates at 475 r.p.m. and is directly connected to a gasoline engine.

Net plant production and fuel economy for the first eight months of operation are given below.

Month	Kw-hr. Produced (Net)	Fuel Kw-hr. per gal.
January	82,890	8.21
February	99,640	7.80
March	95,820	8.01
April	103,800	8.18
May	110,970	8.35
June	122,090	8.75
July	140,410	8.87
August	169,310	9.18

This gives an average of 8.42 kw-hr. per gal. of fuel oil. The average number of kilowatt-hours generated per gallon of lubricating oil is 1270.

West Texas Utilities Co. now has work under way on its Concho generating station, located near San Angelo, increasing the generator capacity from 15,000 to 35,000 hp. The new unit is a 20,000-hp. turbine-generator made by Allis-Chalmers Manufacturing Co. Two 1000-hp. boilers have also been purchased from The Babcock & Wilcox Co. The company is also carrying on work at the Nasworthy Dam on the Concho River. This project includes a 45-ft. dam, 6000 ft. long, the reservoir to extend up the Middle Concho River and South Concho River to give a storage capacity of 10,500 acre feet. Rehabilitation of San Angelo's water supply will be completed with this dam. Below the large dam now under construction will be three dams, each of which will impound 1,750,000 gal. of water. Upon completion of the steam unit at the Concho generating station, the West Texas Utilities Co. will have available 105,000 hp. of electrical energy.

Control Equipment *for* Synchronous Motors

Part I. General Considerations. Principles of the Synchronous Motor. Operation. Fundamentals of Synchronous Motor Control

By C. P. ROBINSON
Ideal Electric & Mfg. Co.

SYNCHRONOUS MOTORS have been understood, in general principles, for 20 yr. or more, but it has only been during the last 10 yr. that this type of motor has acquired wide application in many fields of industry. Steel mills, cement mills, paper mills, refrigerating plants and pumping stations represent but a few of the many uses to which the synchronous motor has been adapted.

During the early stages of synchronous motor development, even after its general acceptance as a motor with suitable characteristics for many industrial drives, its progress in number of installations was slow for a time, due to the difficulties encountered in starting and synchronizing the motor. It was considered quite an engineering feat to start a synchronous motor properly. Industries were quite generally convinced as to the merits of the synchronous motor, but hesitated to install one, believing that no one but a skilled operator could start such an installation successfully. Skilled operators were few.

In the last few years, however, the difficulties connected with synchronous motor starting have been eliminated with a subsequent wide increase in number of installations. This has been accomplished to some extent through improvement in motor design, but largely through the development of proper control apparatus.

Progress in the art of designing control for synchronous motors has been maintained in accordance with developments in other lines of electrical endeavor. Automatic starters have now been in use for several years, permitting remote control and the use of unskilled operators.

Fundamentals of the Synchronous Motor

In order to explain better the functions of a synchronous motor control panel, it will be well to introduce a brief discussion of this type of motor.

The conventional engine type synchronous motor consists of a stationary element called the stator and a rotating element known as the rotor. The stator is made up of sheet steel laminations bolted solidly together

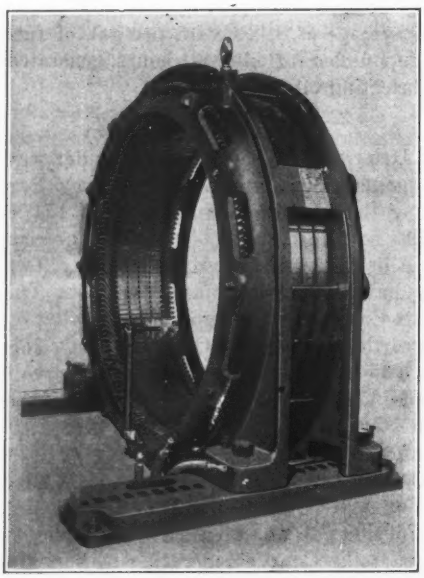


FIG. 1. ENGINE TYPE STATOR CONVENTIONAL DESIGN

FIG. 2. FLYWHEEL TYPE STATOR

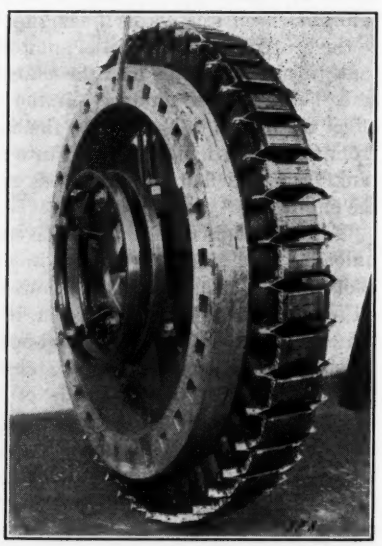


FIG. 3. CONVENTIONAL ENGINE TYPE ROTOR

between end frames. In the faces of the laminations, slots are punched which carry the well insulated alternating current windings. The windings are connected according to the speed desired and also in accordance with the requirements of the primary power supply as to voltage, frequency, and number of phases. Terminal leads are brought out of the stator frame for connection to the primary power supply through the main line switch. Figure 1 shows an engine type stator of conventional design. Figure 2 shows a stator of the flywheel type.

FIG. 4. FLYWHEEL TYPE ROTOR

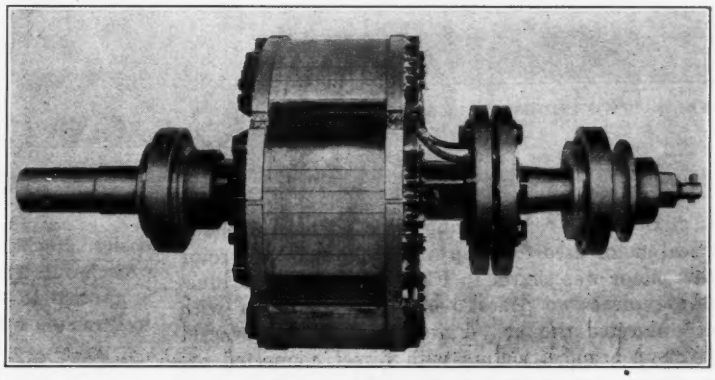


FIG. 5. TYPICAL HIGH SPEED ROTOR

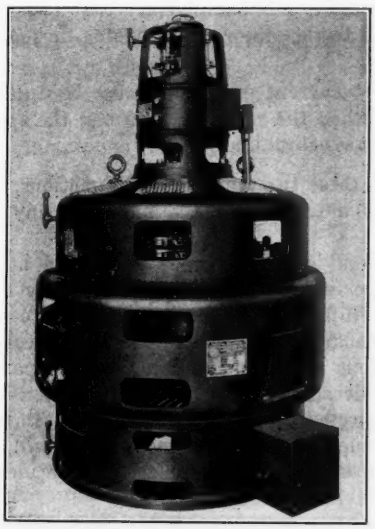


FIG. 7. VERTICAL SYNCHRONOUS MOTOR

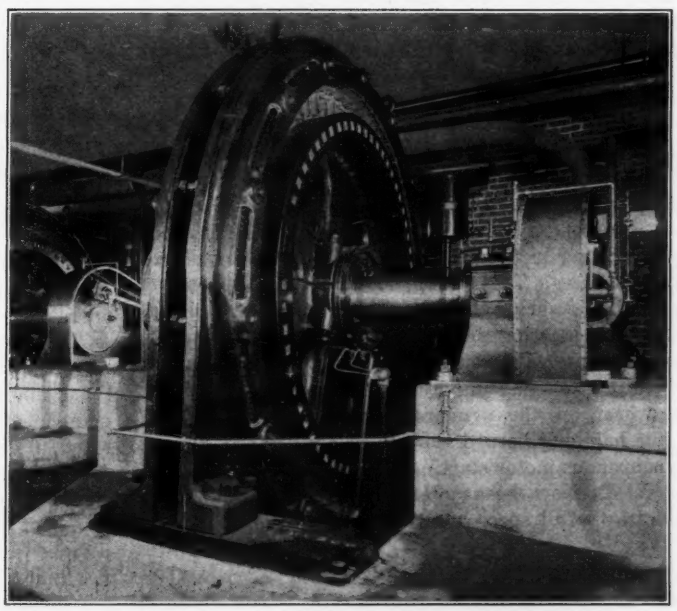


FIG. 6. ENGINE TYPE MOTOR DRIVING COMPRESSOR

Design of the Poles and Field Coils of Rotor and Stator

The rotor consists of a spider, which may be either of laminated steel, cast steel, welded steel, or cast iron, on which are bolted, keyed, or otherwise fastened, the field poles. The field poles consist of laminated steel cores wound with strap copper or copper wire coils. These field coils are connected together in proper relation, and leads are brought out to slip rings. The number of field poles is determined by the fundamental equation of the relation between speed and frequency: r.p.m. = (f $\times$ 60) $\div$ P where r.p.m. = Revolutions per minute, f = Frequency of supply system in cycles per second, P = Number of *pairs* of poles.

The stator, of course, is connected for the same number of poles.

Direct current is then brought from an outside source such as a belted or direct connected exciter, motor generator set, or other source of excitation, to brushes mounted on a brush stand, which apply field current to the rotor through the revolving slip rings. Figure 3 shows a rotor of the conventional engine type. Figure 4 shows a rotor of the flywheel type. The flywheel type synchronous motor differs from the conventional type in that the rotating element is outside the stationary member. Figure 5 shows a typical high speed rotor. This illustration is of a vertical rotor such as would be used for a vertical deep well pump motor. The rotor construction is essentially the same, for horizontal motors of the medium and high speed types, except for the mounting of the bearings.

Figure 6 shows a typical engine type synchronous

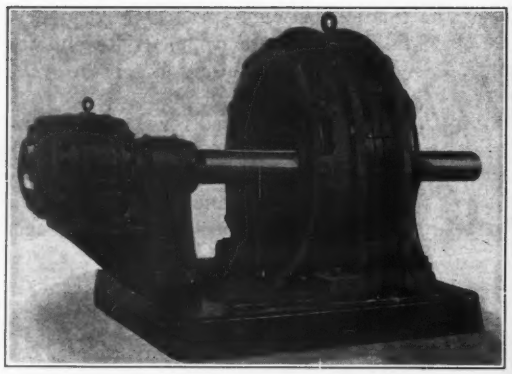


FIG. 8. TWO PEDESTAL BEARING MOTOR

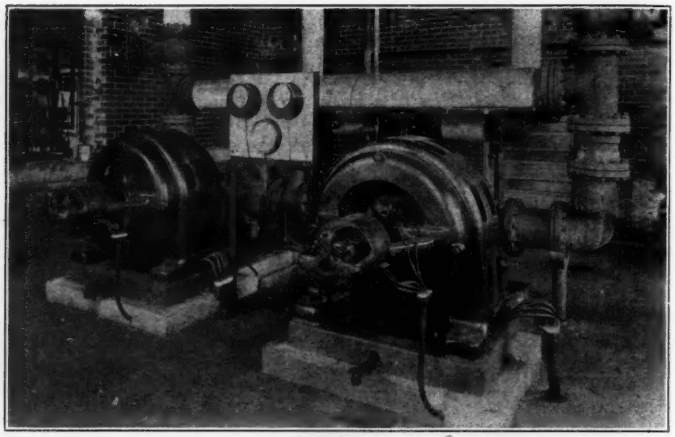


FIG. 9. TWO 2-BRACKET BEARING MOTORS DRIVING CENTRIFUGAL PUMPS

motor at work in a refrigerating plant. Figure 7 shows a vertical motor used for deep well pumping. The rotor for this motor was shown in Figure 5. Figure 8 illustrates a typical two pedestal bearing type motor with direct connected exciter. Figure 9 shows two-bracket bearing synchronous motors with direct connected exciters, driving centrifugal pumps. Figure 10 shows a flywheel type motor with the stator supported from a pedestal bearing which also carries part of the rotor weight. These types of synchronous motors are typical and indicate in general the range of motors covered by the control applications to be discussed.

Operation of the Synchronous Motor

When a synchronous motor is connected to the alternating current power supply, the rotor starts to revolve as the rotor of an induction motor, due to the induced current flowing in the squirrel cage bar winding placed in the pole faces. This type of motor must have squirrel cage winding to bring the motor up to speed, since it has no inherent starting torque as a synchronous motor. Many of the first motors were brought up to speed under light loads by a small induction motor belted to a pulley or flywheel on the synchronous motor shaft. That practice has long been discontinued since the designing of synchronous motor starting windings has become well understood. Now these motors, in many cases, start and accelerate to full speed under heavy loads with special design of the starting windings. When the rotor approaches its synchronous speed, direct current excitation is applied to the rotor field coils, causing the motor to lock in step with the primary power system.

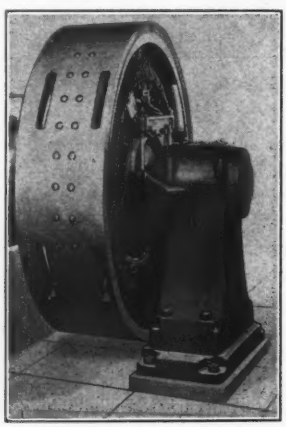


FIG. 10. FLYWHEEL TYPE MOTOR ASSEMBLED ON PEDESTAL

Fundamentals of Synchronous Motor Control

In accordance with the discussion immediately preceding, synchronous motor control panels must first perform two fundamental operations:

(1) The alternating current primary power supply must be connected to the stator of the motor through a suitable line switch.

(2) The direct current excitation must be applied to the slip rings when the rotor has attained the speed at which it can be synchronized.

In addition to these two fundamental functions, the control apparatus must protect the motor during its operation.

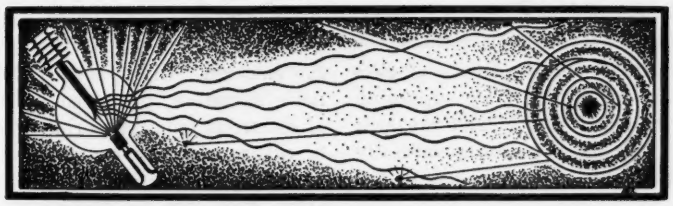
There are several different types of control apparatus available, performing the operations briefly outlined above, but differing in some details as to the manner of performance. Protective features incorporated in the various synchronous motor control panels differ to a considerable degree, depending upon the type of control selected. For this reason, the standard types of synchronous motor control panels will be divided into groups and then more completely identified under the individual group.

New turbine-generator set of 10,000-kw. capacity is approaching completion at the power station at Monceau of the Société Intercommunale Belge d' Electricitè, steam for which will be supplied by boilers working at a pressure of 285 lb. per sq. in. Two 4000-hp. turbine-generators are to be installed, the boilers for which are designed to produce steam at not less than 853 lb. per sq. in.

Dust-proof self-cleaning motors have the windings enclosed in dust-proof covers. Cooling and cleaning are effected by a stream of relatively high velocity air against this cover, the air being propelled by a built-in fan which forms part of the motor proper.

ELECTRICITY —

What It Is and How It Acts*



PART XXXV

By A. W. KRAMER

REVIEWING BRIEFLY the structure of the electromagnetic field described in the previous issue, it was shown that the space about an antenna or oscillating system carrying high frequency current occupied by two components of electric and magnetic fields. One of these is continually moving backwards and forwards from the oscillator so that the energy stored in it by the antenna during one part of a cycle is returned to the antenna in a succeeding interval. This is known as the induction component and is the component responsible for the effect of capacity and inductance and therefore power-factor in ordinary electric circuits. The other component of either field is the one which, having left the antenna, is prevented from returning to it and travels away from it never to return. This is the radiation component and is the one responsible for radio phenomena, as well as light and X-rays.

Each of these components consists of an electric and a magnetic field of force displaced 90 deg. from each other in space but with this difference: The two fields of the induction component are displaced 90 deg. *in time* also, while the two fields of the radiation component are in phase *in time.*

Graphical Representation of Electromagnetic Field

As was pointed out, the fact that these two components are considered, does not imply that two different fields exist; any more than do the two components of current actually exist in an alternating current circuit containing reactance. What happens is this. At a point comparatively close to the antenna, the two fields (electric and magnetic, without reference to any particular component) are both of intense amplitude but are nearly 90 deg. out of time phase with each other. At points more remote from the oscillator, the intensities of both fields fall off and with increasing distance, the *time* phase difference decreases, until at great distances (perhaps a wave length) the electric and magnetic fields are in time phase.

In the illustration, an attempt has been made to show this graphically. The upper row of diagrams represents the actual electromagnetic field in space; the middle row represents the induction component of this field and the lower row, the radiation component. In each case, the vertical arrow represents the direction of the magnetic field and the oblique arrow the direction of the electric field. The angle between them represents the angular displacement in *space,* i.e., 90 deg. The dotted horizontal line in the middle and upper row attempts to indicate time phase displacement, the length of the line being approximately proportional to the time displacement.

The time displacement between the magnetic and electric fields of the induction component (center) is shown to be constant. That is, the electric field of this component is always at a maximum value when the magnetic field is zero and vice versa. The amplitude or the intensity of the fields varies inversely as the square of the distance from the oscillator, the oscillator being assumed to be at the left of the diagram.

In the case of the radiation component (lower row), the time phase displacement is shown to be zero; that is, the electric field of this component is always a maximum when the magnetic field is at a maximum and similarly, both fields pass through zero valves simultaneously. The intensity of this field does not fall off nearly as rapidly as the induction field since it varies inversely *as the distance.*

The actual field depicted in the upper row is the result of combining the induction and radiation fields. The intensity of this field falls very rapidly at first, due to the inverse square variation of the induction component but as the distance from the oscillator increases, the fall in intensity is less rapid and finally, as the effect of the induction field vanishes, it varies inversely as the distance. Close to the oscillator, it will be noted the electric and magnetic fields are displaced nearly 90 deg. but as the distance from the oscillator increases, the time phase displacement becomes less until finally the two fields are in time phase.

Thus, by means of the foregoing description and analysis we obtain a fairly logical picture of the structure, if we may use the term, of the electromagnetic field in free space, based upon our ordinary conception of electric and magnetic fields. While this picture

*All rights reserved.

enables us to apply quantitative values and thereby permits mathematical analysis,[1] in a sense it is unsatisfactory in that it suggests two sets of fields around the antenna.

From the standpoint of the electron, the picture of electromagnetic radiation presented in Chapter XXXI is perhaps more satisfactory. This, it will be recalled, uses the conception of Faraday, that when a charge moves it carries along its electric field and when the position of an electron is changed a disturbance travels out over its field with the velocity of light.

Another Analogy

J. H. Morecroft[2] presents a simple picture of electromagnetic radiation from an antenna, by supposing a large sheet of rubber stretched tightly and clamped rigidly at its boundaries. This sheet is held horizontally and a rod or stick, held vertically is attached to the sheet at the center.

Movement of the stick upwards will pull the center of the sheet upward, and depressing it pushes the center of the sheet downward.

Assume now, that the stick is made to execute simple harmonic motion in the vertical direction. Naturally, the area of the sheet close to the stick will undergo similar harmonic motions but the distant points on the sheet will experience no motion if the motion of the stick is reasonably small. When the frequency of the oscillatory motion of the stick is increased, however, it will be seen that waves are sent out over the rubber sheet and these waves will set into motion the more distant parts of the rubber sheet. That is, points on the sheet so far distant from the stick that steady displacement of the stick produces no perceptible displacement of the rubber sheet will be affected and will move up and down, provided the stick is oscillated with sufficient rapidity. The distortion and motion of the rubber sheet, near the stick when the stick is moved up and down slowly, correspond to the induction fields of the antenna while the distortion and motion of the rubber sheet produced by waves, correspond to the radiation fields.

This is probably the simplest analogy of electromagnetic radiation we can find and after all our attempts to picture complex interaction between electric and magnetic fields, this perhaps is the most effective. After all, our conceptions of electric and magnetic fields are purely imaginary and any method that gives us the most satisfactory explanation is the one to use.

Review of Radiation Theories

We have now considered in some detail the essential facts known about electromagnetic radiation, both as applied to X-rays and light and to radio waves. Before proceeding further, it will be well to pause and review briefly the ground we have thus far covered.

In Chapter XXVI,[3] as will be recalled, we began with a consideration of visible light and its relation to the electron. Light, it was shown, was an electromagnetic radiation, produced by the sudden displacement of electrons from one orbit or energy level in the atom to other orbits or energy levels. Such displacements occurring in the outer orbits or energy levels of the atom give rise to radiation of frequencies between 4×10^{14} and 7.7×10^{14} (from 400 million million to 770 million million) cycles per second. This range of frequencies has the power of affecting the eye and for this reason is known as visible light.

When electromagnetic radiation of higher frequencies than light is encountered, it is known as the X-ray. Such rays, it was shown, were produced by displacements of electrons occupying the inner orbits of atoms.

Next, there was introduced evidence to show that light and X-rays are radiated in quanta or particles, and that the action of these particles accounted for the photoelectric effect.

Finally, radiation having frequencies lower than those of visible light were considered. These radiations, which include those used in radio, it was pointed out are produced not by displacements of electrons in atoms, but by the movement of electrons in conductors, that is, by electric currents.

Thus, we have accounted for electromagnetic radiation varying in frequencies from those of X-rays of some 3×10^{18} cycles per second to long radio waves of 20,000 cycles per second. This, however, does not include the entire known range of electromagnetic radiation, for as will be shown, there are types of radiation characterized by very much higher frequencies than even the highest frequency X-rays. These are the waves associated with radium, and those of cosmic origin. All of this radiation is of the same fundamental nature and differs only in frequency. The structure of light is exactly the same as that shown for long radio waves in the accompanying diagram.

Interaction Between Radiation and Matter

In discussing these various types of radiation, we have endeavored to show in each case how they are related to electrons and atoms but to do this has not always been an easy matter. As long as we confine ourselves either to one or the other, that is, either to radiation alone or to matter alone, we can get along fairly well but as soon as we try to explain the production and absorption of radiation, we are dealing with an interaction of the two and that is where nearly all of the unsolved problems lie.

This attempt to correlate radiation with matter has uncovered some startling facts and has led us to alter

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[1] It can be shown, for instance, that the electromotive force e developed along unit length by a magnetic flux B, moving or expanding with a velocity v is given by the equation

$$e = Bv$$

or

$$e = \mu Hv \quad \ldots\ldots\ldots\ldots (1)$$

where H is the magnetic intensity of the field and μ is the permeability of the material. By permeability is meant the ratio of the magnetic flux density produced in a certain material by a certain magnetic force, compared to the flux density the same force would produce in air.

It can also be shown that the magnetic force H along the same unit length, by an electric flux of density D expanding at a rate v is given by

$$H = Dv$$

or

$$H = \epsilon ev \quad \ldots\ldots\ldots\ldots (2)$$

where ϵ is the permittivity of the medium. Permittivity is a constant, depending upon the nature of the material in which the flux exists.

Multiplying equation (1) by (2) and solving for the velocity of propagation, we find

$$v = \frac{1}{\sqrt{\epsilon \mu}} \quad \ldots\ldots\ldots\ldots (3)$$

In a vacuum the values of ϵ and μ are: $\epsilon = 8.85 \times 10^{-14}$ farads per cm^2 and $\mu = 1.257 \times 10^{-8}$ webers per amp. turn. The weber is the unit of flux. Substituting these values in equation (3), we find the velocity of propagation is

$$V = \frac{1}{\sqrt{(8.85 \times 10^{-14} \times 1.257 \times 10^{-8})}} = 3 \times 10^{10} \text{ cm. per second}$$

which is equal to the measured velocity of light.

[2] Principles of Radio Communication, 2nd edition, page 819.

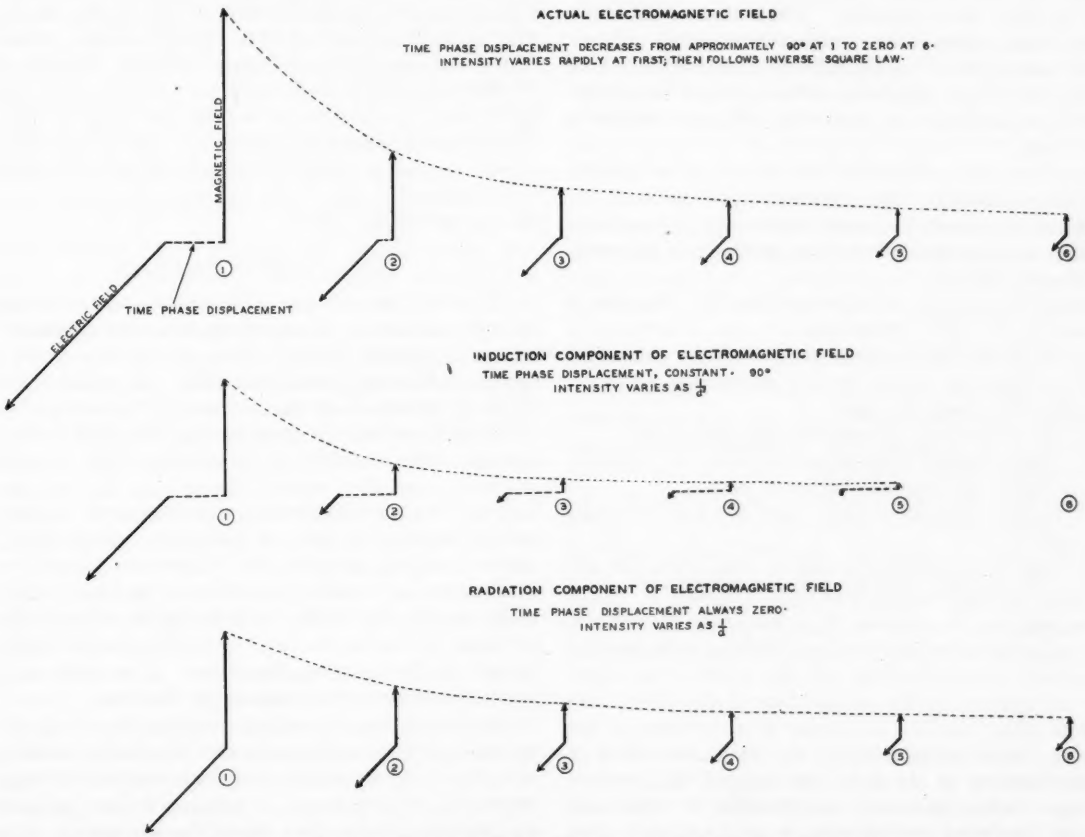
[3] August 15, 1929 issue.

our ideas about certain things. Light, for example, thirty years ago was fairly well understood. It was considered a wave in the ether, and its laws of refraction and reflection and polarization were definite and conclusive. Just a few years ago matter, too, was quite definitely understood. Matter was composed of molecules and atoms, and atoms in turn were made up of electrons and protons. Electrons and protons were thought to be particles, and by their configurations we accounted for all of the known elements.

When an attempt was made, however, to explain one in terms of the other, straightway we found ourselves in trouble for when we tried to explain the structure of the light wave, it remained no longer a wave but took on the semblance of particles, and the electron, when an attempt was made definitely to prove it a particle, began to act as a wave. To deny that this state of affairs constitutes somewhat of a dilemma would be dishonest, but it need cause no discouragement since the very fact that both the electron and the light wave refuse to comply with our preconceived notions about them has opened up vast new avenues of thought. It has opened up an entirely new field of analysis, and the work of the pioneers in this field, de Broglie, Schrodinger, Dirac and others, is already yielding fruitful results. These matters will be discussed more fully later.

Considered alone, that is apart from each other, what we know about light and about the electron is quite definite and it is not likely that further advances in knowledge will greatly affect our practical application of our present knowledge of the electron and light any more than did the extension of our knowledge by the Einstein theory affect our application of Newton's law of gravitation.

Whether the electron is a particle or a wave, we know definitely that it possesses an electrical charge and also mass. We know that this charge is equal to 4.774×10^{-10} absolute electrostatic units and that the mass is 8.8×10^{-28} grams. More recently its wave length for certain speeds also has been determined but in this case there may be an element of doubt. For an electron moving at a speed of 10^{10} cm. per sec. (about $\frac{1}{3}$ the speed of light) G. P. Thomson determined the wave length to be 7.8×10^{-10} cm.



AN ATTEMPT TO SHOW GRAPHICALLY THE STRUCTURE OF THE ELECTROMAGNETIC FIELD

With regard to light and other forms of electromagnetic radiation, we know definitely that their speed in vacuum is 3×10^{10} cm. (186,000 miles) per sec. and that this speed is the product of the frequency and the wave length.

Using these basic facts regarding the electron and radiation, as a foundation, there has been constructed a logical theory capable of accounting for nearly all ordinary phenomena in physics and chemistry and optics. From the production and effect of X-rays and from the photoelectric effect, we know also, that electromagnetic radiation is intimately associated with the movement of electrons. From extended investigation into all of these matters there has been built up the electromagnetic theory of radiation described here.

Legal Questions Involved in Making Purchases

A Discussion of the Validity of Sales Contracts and Guarantees Made by Salesmen of Plant Supplies. By Leo T. Parker*

IT IS A WELL recognized fact among law experts that the majority of litigations might have been avoided had the litigants acquired elementary principles of the law.

Obviously, engineers cannot obtain knowledge of all branches of legal procedure and at the same time prove adept in their own business. When it is considered, however, that engineers are subjected to pitfalls of litigations arising from comparatively few sources, it is easy to realize that acquiring sufficient legal knowledge to avoid successfully the majority of controversies is not difficult.

Therefore, the purpose of this article is to explain clearly the elementary and important principles of the established law which will assist materially in determining when a guarantee or contract made by a salesman is valid and effective.

Generally speaking, a sales contract for supplies is valid and enforceable, provided:

(1) The seller, or his authorized employe, submitted an offer which the buyer, or his authorized employe, unconditionally accepted, and

(2) The objects of the contract are lawful, and

(3) Neither party misrepresented facts or practiced fraud to induce making the contract, and

(4) Both principals were of legal age and of sound mind, and

(5) The price, quantity, quality and time for delivery of the merchandise is clearly specified.

Contrary to the opinion of a majority of persons, however, a signed order given a traveling salesman by an engineer is not binding on the latter's employer, unless it is proved to the satisfaction of the Court that the seller *either notified the buyer of acceptance of the order, or began manufacturing the goods according to the specifications of the order, or shipped the goods to the buyer before receiving cancellation, or did some other act involving an expenditure, while relying upon the sincerity of the order.*

Moreover, it is important to know that a seller is not bound by the statements or guarantees made by his traveling salesman, nor is the seller bound to ship an order in accordance with the verbal or written promises of the salesman, unless the seller has in some manner caused the buyer or his authorized employe to believe that the salesman is possessed of proper authority to make binding contracts of sale.

On the other hand, the law is well established that since the relation of principal and agent exists between a firm and its traveling salesman, the firm is responsible for the acts which the salesman commits within the scope of his authority. Moreover, a general authority to transact business may be conferred purposely or unintentionally upon a salesman, under which circumstances the manufacturer is liable for contracts, promises, or guarantees made by its salesman.

*Attorney at Law, Cincinnati, Ohio.

It is important to know that the law recognizes two classes of agents or employes, namely, general and special. A manager is a general agent, because he is employed to perform all acts necessary to the successful conduction of the business. A salesman is a special agent whose authority is limited to the performance of a single act or a special kind of service for his employer. The accomplishment of this special service, however, may necessitate the performance of many different acts.

The employer is liable only for such acts of a special agent that are performed within the scope of the authority given him by his employer. Moreover, when the special service is rendered, the special agent's authority is automatically ended and his employer is not responsible for subsequent acts.

Guarantees by Salesmen

It is well settled that a manufacturer is not bound by any contract or warranty made by its salesman, unless it is proved to the satisfaction of the court that the manufacturer performed some act which led the buyer to believe that the salesman had such authority.

This effect may be produced by actually giving the salesman the authority or permitting him to make a guarantee and then acknowledging it to the engineer in language which indicates that the former is satisfied to accept contracts of sales or agreement containing guarantees, made by its salesmen. Therefore, where a salesman makes an unusual contract or warranty and the seller accepts the order, he is bound to acknowledge it in terms indicating to the buyer that special authority is not conferred upon the salesman to make binding contracts without confirmation of the firm.

A certain way by which a selling firm may be responsible for all agreements and warranties made by a salesman is to formulate a written contract of employment with the salesman in a manner that indicates to an engineer buyer, who reads the salesman's copy of the agreement, that authority is conferred upon the salesman to make valid agreements. This point of the law has been decided by numerous courts.

The facts of the leading case on this subject will impart valuable information. In this case, a manufacturer employed a salesman who had authority only to solicit orders and send them to his employer for acceptance. The salesman solicited and received an order for a large quantity of equipment and accessories from an engineer who had authority to purchase the equipment. The order was in writing and signed by both the engineer and the salesman.

Upon receiving the order from the salesman, the manufacturer immediately wrote the buyer, explaining that the order was unacceptable because the stipulated price was too low. The seller stated that if the engineer would agree to accept a cheaper quality of merchandise the order would be shipped immediately. On the same day, the manufacturer wired instructions to the sales-

man to visit the engineer and obtain another contract at a higher price.

The salesman visited the engineer and explained that it was necessary to cancel the original order and attempted to obtain another order in accordance with his employer's instructions. While conversing with the engineer the salesman received from his employer the following telegram: "Do not lose this order. *Get the best contract possible and send it in.*" The salesman *did not permit* the engineer to read the telegram but proceeded with the negotiations. The engineer refused to pay a higher price and the salesman finally accepted another order at exactly the same price that was specified in the first order. Also, this latter order required the buyer to pay $100 immediately and the remaining $400 was to be paid on receipt of the bill of lading. The engineer obtained a signed check for $100 from his employer made payable to the salesman's employer. The salesman immediately forwarded the check, together with the order, to the manufacturer explaining that the contract was the best he could obtain.

Manufacturer Accepts Check

Immediately after signing the second order and giving it to the salesman, the engineer dispatched a telegram to the Chicago firm, as follows: "Want you to confirm Stannon's (salesman's) contract with me. He made no change in price or terms as first given. He accepted payment." The manufacturer did not answer the telegram but, upon receipt of the order and the check for $100, deposited the check in the bank. The check was duly paid by the bank upon which it was drawn.

Several days later the manufacturer sent his check for $100 to the engineer's employer, explaining that the contract price was too low and stated that the merchandise would not be shipped. The buyer refused to cash the check and returned it with a letter demanding that the order be filled.

Upon failure of the manufacturer to fill the order, the buyer instituted legal proceedings to recover the $100, together with $600 damages alleged to have been sustained because of the manufacturer's refusal to comply with the terms of the contract of sale.

It is important, however, to observe that in the face of these circumstances, the court held the manufacturer not liable, and explained that a firm is not required to accept and fill orders solicited by its traveling salesman, unless the manufacturer has by his conduct led the buyer to believe that the salesman has special authority.

If, however, the salesman had permitted the buyer to read the telegram received from the manufacturer requesting the salesman to "get the best contract possible," probably the buyer would have been entitled to damages, because under these circumstances the court may have held that this telegram *indicated that the salesman had authority to make binding contracts.*

For instance, in numerous cases the courts have held that where evidence is introduced to prove that an engineer has been led by the salesman's employer to believe the salesman has authority to enter into contracts or make guarantees, he is justified in making the contracts and the salesman's employer is liable for fulfillment of the agreement.

These courts, however, invariably explain that an ordinary salesman is legally authorized only to solicit orders and transmit them to his employer, but if while exercising "ordinary care" and prudence the purchaser believes the salesman has the authority to bind his firm to guarantees or contracts, then and only then may it be implied that the employer is bound by the acts of the salesman with respect to the particular transaction.

On the other hand, it is important to know that a selling firm may be liable for contracts of sale or guarantees made by its representative, if the custom in the territory, in which the contract was made, is that salesmen have authority to make valid contracts for their employers.

Also, in a recent case a court held a manufacturer bound by a guarantee made by his salesman, where it was proved that the manufacturer had previously explained in a letter received by an engineer that the salesman possessed authority to enter into binding contracts for the sale of merchandise.

Another court explained that although an employer does not authorize his salesmen to sign contracts and does not lead others to believe that his salesmen have such power, yet a contract made by the unauthorized agent will be held valid if the employer fails, within a reasonable time, to notify the other party that the agent has exceeded his authority (285 S. W. 516).

It is, also, well established that a selling firm is not responsible for acts done by its salesman outside the scope of his authority. For example, in a recent case it was shown that a salesman, whose authority was limited to soliciting orders, collected money from a purchaser as payment for goods previously shipped. The salesman misappropriated the money and the customer sued the salesman's employer to recover the amount paid. It is interesting to observe that the court held the employer not required to credit the customer's account with the money which he had paid to the salesman.

Printed Notices on Order Blanks

It is certain that a printed notice on a salesman's order blank is important evidence in a controversy of this kind. For example, in a recent case it was held that a selling firm is not liable for an unauthorized guarantee made by its salesman where it is disclosed that the salesman's order form contains a notice saying in effect, "Our salesmen have no authority or power to enter into binding contracts for the sale of merchandise, or extend guarantees, or alter this agreement, or to bind us by verbal agreements."

Therefore, it is quite apparent that engineers who deal with salesmen should obtain a written statement from their employers that the salesmen have authority to make binding contracts. Otherwise, the legal effect of an order solicited and taken by a representative, and all verbal and written guarantees, agreements, and promises are subject to cancellation and repudiation by the employer.

It is also well established, however, that if a salesman deceives an engineer when soliciting an order and makes false statements by which the latter is induced to sign a contract, the engineer's employer is not bound

to accept the merchandise and pay for the same (279 S. W. 531).

Since an order for merchandise signed by an engineer or any other authorized person, is a mere offer to purchase merchandise, conversely the offer is *not* a binding contract with respect to the engineer's employer until accepted by the salesman's employer. Therefore, the engineer has the same privileges as the seller and he may cancel the order at any time *before* the selling firm sends its acceptance.

For example, in the recent case of McCasky vs. Bowman, 287 S. W. 755, it was disclosed that a seller gave a signed order to a salesman for merchandise. Two weeks after signing the order, the purchaser verbally notified the salesman that he did not want the goods. About 10 days after this, the salesman's employer wrote, refusing to accept the cancellation of the order and proceeded to ship the goods. The purchaser refused to accept the shipment and the seller filed suit on the grounds that the order blank contained a printed stipulation that the order was *not* subject to a cancellation. The higher court, however, held the buyer *not* liable on the contract of sale, and said:

"A countermand of an order of goods received before their shipment is effective, as no contract is made until after the offer of purchaser is accepted."

It is well settled law that the employer of an engineer is liable for contracts of sale signed by the engineer authorized to make purchases, irrespective of private instructions.

For illustration, in the recent case of Bain vs. Pinson & Guyger, 287 S. W. 87, an employer instructed his employe to submit the details of all contracts of sale for approval before the same were signed; however, the employe failed to do this and concluded the purchase of the supplies without conferring with his employer. The latter refused to pay for the merchandise contending that the employe had exceeded his authority. The court, however, held the employer liable and explained the law on this subject, as follows:

"It is well settled, where a principal had delegated to an agent certain authority, that secret or private instructions or limitations as to the manner of exercising the power granted, however binding such instructions may be between the principal and his agent, *can have no effect on a third person* who deals with the agent in good faith in ignorance of the instructions or limitations and in reliance on the apparent authority with which the principal has clothed him."

Cavitation in Hydraulic Turbines

ANALYSIS OF CAUSES OF CAVITATION, FACTORS INFLUENCING CORROSION AND MEANS OF AVOIDING CAVITATION. BY F. JOHNSTONE-TAYLOR

CAVITATION has long beset those who design and build hydraulic turbines of the reaction class, especially the modern type of high-speed unit operating on low falls. When designers turned their attention to hydraulic turbines to operate at the maximum possible speed, a good deal of wasting away of the runner blades became apparent. This was attributed in the first instance wholly to erosion, since the trouble occurred with water that was not highly corrosive or certainly not corrosive enough to be the main cause of the trouble. Then with the use of bronze runners (which are desirable from many standpoints) it was found that there was relatively little wastage. This pointed conclusively to the fact that iron and cast steel runners especially are attacked by the corrosive elements in the water.

Further investigation revealed little of this effect upon the stationary parts of the turbine such as the scroll case and speed ring but led to the supposition that entangled air was at the root of the trouble and finally that the water, by following only the contour of the blades at one particular velocity, promotes air pockets and eddies that cause the blades to be alternately wet and dry when deviations from the critical velocity occur. Experience in the design and construction of modern high speed turbines of the propeller type has proved that the relative position of the runner, the tail race and the shape of the suction pipe must all be carefully coördinated, to avoid corrosion conditions that arise if the pressure on the lower side of the blades falls to evaporation limit. The main trouble, therefore is cavitation.

Cavitation itself is not a mysterious phenomenon. It is caused by the fundamental property of water to evaporate at a sufficiently low pressure even when the temperature is quite normal. If the outer pressure drops to the vapor pressure corresponding to the momentary temperature of the water, a formation of bubbles will result which may set up intensive corrosion. If the water contains dissolved gases, these are also liberated at low pressures. The question now arises as to how these low pressures arise in turbines and where the critical points are to be sought.

Take, for instance, a low head turbine provided with the usual draft tube. There will be so many feet suction head, causing so many inches of vacuum back of the turbine runner but not in direct proportion; that is to say, the vacuum would only be equal to the static suction under the assumed condition of a complete closure of the guide apparatus. As soon as flow commences, the pressures under certain circumstances vary considerably. For economical reasons, the turbine diameter is chosen as small as possible. As a consequence, the water, leaving the wheel, is still agitated and represents a kinetic energy which cannot be neglected. If the draft tube is of cylindrical form, the water must retain its velocity and the energy is completely lost. For this reason, attempts are made to discharge the water from the draft tube with the least possible motion and disturbance, by enlargement, by a diffuser arrangement or otherwise. But for a simple stationary tube to recover the energy of the water leaving the runner, work must be done and moving parts must be available.

Such moving parts are, naturally, the turbine blades; the draft tube when properly designed has the effect of reducing the pressure below the blades and thus increasing the head acting on the runner, the sum of pressure energy and kinetic energy being constant.

Influence of Blade Shape

If one assumes the turbine to have many blades and, consequently, narrow channels, then according to accepted turbine theory, there is a continuous decrease of pressure in the moving channel from inlet to outlet. The lowest pressure prevails at the outlet and is identical with the pressure calculated from barometer level, draft tube recovery and static suction head; however, the development of high speed turbines has resulted in avoiding narrow channels and the total blade surface is considerably reduced in order to reduce friction losses at high speeds, an idea followed up by Kaplan who obtained high speeds with very short blades. But serious difficulties arose, due in the main to cavitation, and, while these turbines function well at low heads, they may prove practically useless under higher ones. The only remedy is to increase the blade surface, thus reverting to the older forms. Thus there arise two conflicting conditions: friction requiring small surfaces and cavitation to be avoided by the use of large surfaces.

By extending blades, "channels" are again formed and thus the older wheel form is approached, the local vacua disappear, the admissible values of the cavitation index s, become smaller and the danger of cavitation is diminished. For a certain high speed corresponding to a specific speed of approximately 600, the curve in Fig. 1 is obtained, with s plotted against the l/T value, which shows that the extension of the blades is effective at first but less so later. There is a limit, therefore, to the length of blade which can be conveniently used. That the local vacua become large with small blade surfaces is also seen when the axial thrust of the water (approximately equal to the head multiplied by the wheel surface) is distributed over the blades, which, of course, have to carry the head resulting in higher specific pressure for smaller surfaces. But such blade surfaces take up forces not only through the action of pressure on the concave side but also through the action of vacuum on the convex side. This makes it clear that the vacuum increases with diminishing surfaces and equal total load.

Factors Influencing Corrosion

Cavitation will exist under certain conditions and it is a serious evil that will occur as soon as the pressure on the back of the blades is reduced to the vapor pressure of the water and it will cause corrosion and possibly erosion. The latter appears to be the cause of a good deal of trouble with propellers of ships. According to a British Admiralty report in 1917, the corrosion of propellers is but slight though erosion is serious, caused by the hammer action of the water on the blades which in turn is caused by cavities closing up on the surface of the blade.

From calculations made in connection with the report, it appears that the pressure produced by the water hammer is independent of the size of the cavity, depending only upon the rate of its contraction. Hence the cavities causing the erosion may be large or small. Cavitation itself, however, will produce only erosion when accompanied by conditions which will cause the cavities to collapse in such a way and in such a position that the energy of the collapse is concentrated on a small proportion of the blade surface. In support of this water hammer theory, it has been found in turbines that the first visible sign of cavitation is that some spots on the blades get a silvery surface which seems to arise from hammering and these spots have, at later inspections, shown the worst effects of erosion. It is also probable that chemical action is an important factor in the destruction of the blades, which could be explained by the fact that the air which is liberated in the cavities is

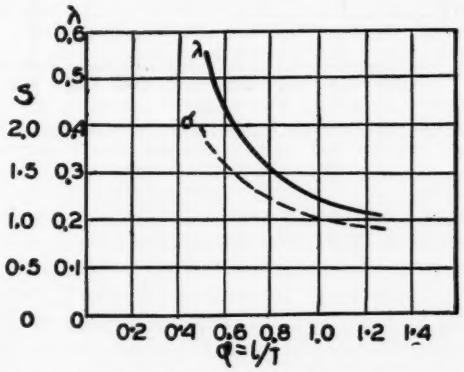


FIG. 1. VALUES OF S, THE CAVITATION INDEX AND Y, MINIMUM PRESSURE VALUE COEFFICIENT, AS FUNCTIONS OF RATIO OF BLADE LENGTH TO PITCH, L/T, FOR A SPECIFIC SPEED OF ABOUT 600

damp and heavily charged with oxygen that rapidly attacks the blades when liberated.

Means of Avoiding Cavitation

As corrosion and erosion, especially in the case of high speed runners depend in the main on cavitation which in turn is caused by reduction of pressure, it is necessary to consider the factors upon which this depends in practice. A high suction head, for instance, is a direct cause of the trouble and this must be kept as low as practicable, thus rendering a propeller type turbine generally unsuited to a horizontal setting. Then there is the velocity head regained in the suction pipe; the greater this is, the greater is the reduction of pressure on the back of the blades. It must be kept, therefore, as low as possible by an amply-dimensioned runner. The length of the blade in the direction of flow compared with its pitch has also to be considered. High speed runners, from the standpoint of reducing friction, have a short blade length as compared with the pitch, but this, as already pointed out, leads to a greater specific pressure on the blades which increases the danger of cavitation. The greater the head and the suction head, the longer must the blades be made, and the lower in consequence is the specific speed. The greatest lengths of blade used up till the present for Kaplan turbines have not much exceeded the pitch, though there is nothing against the use of overlapping blades except that it will necessitate more than four, a practical disadvantage

in the case of movable blades as used in the Kaplan turbine. On the other hand, for propeller turbines with fixed blades, a considerable overlap can be arranged at moderate specific speeds, so that these turbines may be used for somewhat higher heads.

Finally cavitation also depends upon several other factors, such as the shape of the blade, the peripheral speed of the runner, the temperature of the water, etc.,

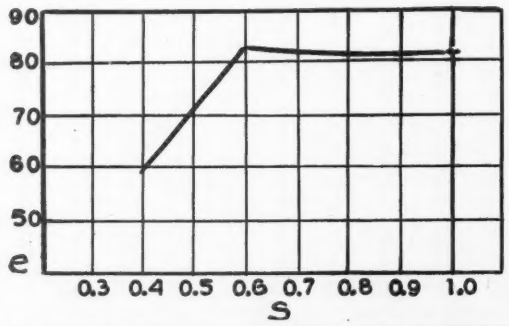


FIG. 2. EFFICIENCY OF A KAPLAN TURBINE WITH FIXED RUNNER WHEEL AND GUIDE BLADES AS A FUNCTION OF S, THE CAVITATION INDEX

rendering it almost impossible to calculate theoretically the cavitation limit. The influence of these factors may be estimated approximately, but for a final determination it is necessary to conduct experiments to determine the suction head permissible for each head and speed for different types of blade. With the object of studying the problem, Messrs. Escher Wyss of Zurich, to whom the writer is indebted for the data upon which these notes are based and The Verkstaden Co. of Kristinehamn have erected special laboratory testing plant and the latter is described at some length by Elov

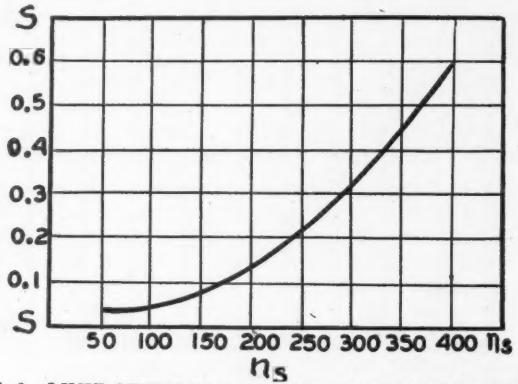


FIG. 3. LIMIT OF VALUES OF S, THE CAVITATION INDEX, FOR FRANCIS TURBINES, ACCORDING TO THOMA

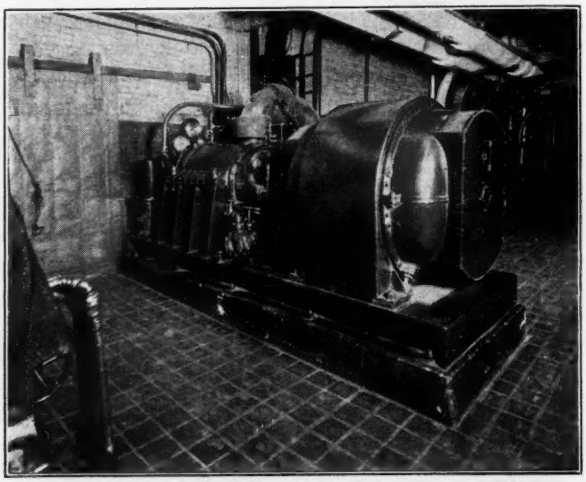
Englesson in Engineering of April 16, 1926. By means of organized tests an efficiency curve can be furnished for different s values by varying H_o and H_{dyn}.

Figure 2 illustrates an example in which the efficiency rapidly decreases below s = 0.6 owing to cavitation. With this wheel the minimum value of s should not be less than 0.8. If the s values ascertained by experiment are plotted, for different types characterized by their specific speed, a curve is obtained, giving a good indication of the limits of application. Figure 3 illustrates such an s curve according to Herr D. Thoma of Munich, who has done much to bring light to bear upon the matter of cavitation. This curve represents the present limit values for s which should not be exceeded. At the same time, the value of such curves is limited: they have a similar character to the yield point of metal in that under certain conditions they may vary considerably due to circumstances.

Lakeside Boiler Feed Pump for 1500 lb. Pressure

FEED PUMPS for high pressure boiler feed service offer problems which differ greatly from those designed for low or medium pressure service. As with other pieces of equipment intended to serve high-pressure plants, however, these problems have been successfully solved.

The accompanying photograph shows a 4-in., six-stage pump installed at Lakeside station. This is a Worthington pump designed to deliver 300,000 lb. of



A WELDED STEEL BASE PLATE IS USED FOR THIS NEW LAKESIDE STATION FEED PUMP

360 deg. F. water an hour against a discharge pressure of 1470 lb. per sq. in. The suction pressure is 360 lb. per sq. in.

It is a vertically-split section type in which each stage piece, suction and discharge ends, made of cast steel, are held in place by through bolts, the nuts of which are visible in the photograph. The outboard end of the shaft is fitted with a Kingsbury thrust bearing pressure lubricated by an independent oil pump. One of the interesting features of the design is the welded steel base plate. The pump is driven at 3600 r.p.m. by an Allis-Chalmers 800-hp. motor.

Similar pumps, driven by 3600-r.p.m., 600-hp. motors, will be used in the new South Amboy plant. These will be seven-stage pumps, delivering 137 to 740 g.p.m. against a differential head which will vary from 1350 to 765 lb. The water temperature will vary from 324 to 500 deg. F.

IN IMPULSE TURBINES, the nozzles are stationary and the steam jets act on turbine vanes; in reaction turbines, the nozzles or their equivalent are mounted on the rotor which is driven by the reaction of the jet.

Comments on Refrigeration in Industry

SCOPE OF INDUSTRIAL PROCESSES AND CHEMICAL REACTIONS IS CONTINUALLY WIDENED BY NEW APPLICATIONS OF REFRIGERATION

USES OF REFRIGERATION in industrial processes have been increasing rapidly during the past few years. This is particularly true in industries that employ chemical reactions, since they have been enabled by the use of modern refrigerating equipment and control methods to conduct reactions not otherwise possible or

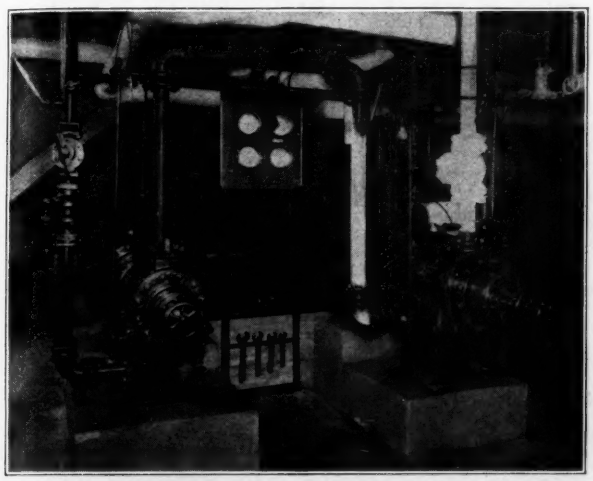


FIG. 1. MULTIPLE-EFFECT, TWO-STAGE AMMONIA COMPRESSOR DRIVEN BY FLYWHEEL TYPE SYNCHRONOUS MOTOR

else extremely difficult. Textile mills, powder factories, dairies and milk product plants, food products and many other industries have in various ways employed direct refrigeration in their work. In the meat-packing industry it has long played an important part. In the making of cereal beverages, bread, yeast and other products in which fermentation is a factor, many developments have occurred in which refrigeration has been a vital factor. For cooling drinking water in large buildings, hotels and industrial plants, it has proved a boon in saving trouble, space and money. It has made possible the transporting and storing of fruits and vegetables to compensate for the seasons and in many other ways has proved of inestimable benefit.

Interesting applications have been made of refrigeration in tempering metal. In making plows, for example, it has been found that by maintaining the tempering bath at a uniform low temperature, the tempering of the plow can be improved. Some engineers used sodium chloride brine, while others preferred calcium chloride, maintaining that it increased the hardness and toughness of both plow points and mold boards. Such a sodium or calcium chloride bath is felt to be much better than water, since the formation of steam on the surface of the hot metal prevents the water from acting quickly on the metal. The sodium or calcium chloride prevents the rapid formation of this steam, allowing the cold brine to produce the proper hardening effect.

Many oil refining processes employ low temperatures at certain points in the cycle. For example, paraffin wax is sometimes precipitated by refrigeraton. Many absorption plants are used for this work, as well as compressor installations. This process is typical of several others in which congealing or precipitation of a solid product can be brought about by cooling.

Figure 1 shows a recent interesting compressor installation in a large ice cream plant. This is a multiple effect, 2-stage compressor, equipped with clearance pockets for reducing capacity when desired and designed so that three suction pressures can be used at once. These pressures are: (1) about 8 in. vacuum to give about —30 deg. F. in the hardening room; (2) about

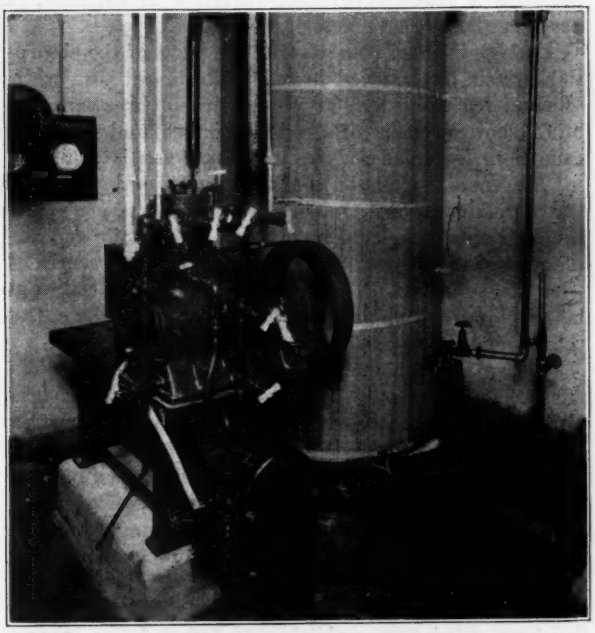


FIG. 2. SMALL AMMONIA COMPRESSOR COOLING DRINKING WATER IN BUILDING. MOTOR DRIVES COMPRESSOR BY MULTIPLE V-BELT DRIVE. STEAM TRAP IS USED INSTEAD OF EXPANSION VALVE

5 lb.; (3) about 25 lb. To get these suction pressures, one suction line at 5 lb. returns to one end of the cylinder, the low-temperature suction line to the other and the 25-lb. suction line connects to multiple-effect ports at the middle of the cylinder. These ports are uncovered by the piston as it passes, just before it is ready to return. Between cylinder and frame is a chamber longer than the stroke, with high-pressure packing at one end and low-pressure packing at the other, termed "double-seal," to prevent rod trouble and drawing in of air.

This compressor is a 10 and 8 by 10-in., 2-stage machine, driven at 300 r.p.m. by a 100-hp. flywheel-type

synchronous motor, mounted on a special bracket. The motor-generator set is mounted on the trunk piece connecting high and low-pressure cylinder frames.

Figure 2 shows a small compressor cooling water for a building. It operates automatically to keep the water temperature, in the tank behind it, at 46 deg. F., the thermostat starting the compressor when the water in the tank goes up to 47 deg. This work is done, as shown on the gage, at a suction pressure of 60 lb. absolute, corresponding to about 40 deg. F. The good heat transfer is attributed partly to the fact that the cooling coils in the tank are ample and are arranged so that there is no core of warm water flowing up through them. Another interesting feature of this installation is the omission of an expansion valve; this is replaced by a bucket-type steam trap, which allows only liquid ammonia to pass over but will close as soon as gas tries to flow. In this way, practically all the ammonia in the system is kept in the coils.

During the past few years, interest has again been revived in the absorption system of refrigeration, which has been applied many times especially for extremely low temperature work, its best field. Where a low temperature is required without variation in capacity, it has served most satisfactorily.

New methods of constructing the parts of the absorption system have served to reduce its initial cost, while schemes for using booster pumps driven by steam turbines show promise of good economies under proper conditions, especially where exhaust steam is available.

Air conditioning, of course, offers a wide field for use of refrigeration. One of the most interesting recent developments is the cold room where automobile and airplane engines are tested. Not only are temperatures of —20 to —50 deg. F. maintained by cooling coils but large blowers can produce high winds in these test rooms, simulating outdoor conditions.

Carbon dioxide snow or dry ice is a recent development that has already been used for storage refrigeration and transportation with great success and certain industries will doubtless take advantage of it. The silica gel refrigerator car has also been arousing much interest for transporting fruit, vegetables and fish.

Quick freezing of meat products is being tested by some packing houses, using extremely low temperatures, as pointed out by Rollo E. Gilmore in our December 15, 1929 issue. The Waltham process for storing ice cream has been developed, consisting of frozen brine in arc-shaped containers surrounding the ice cream can.

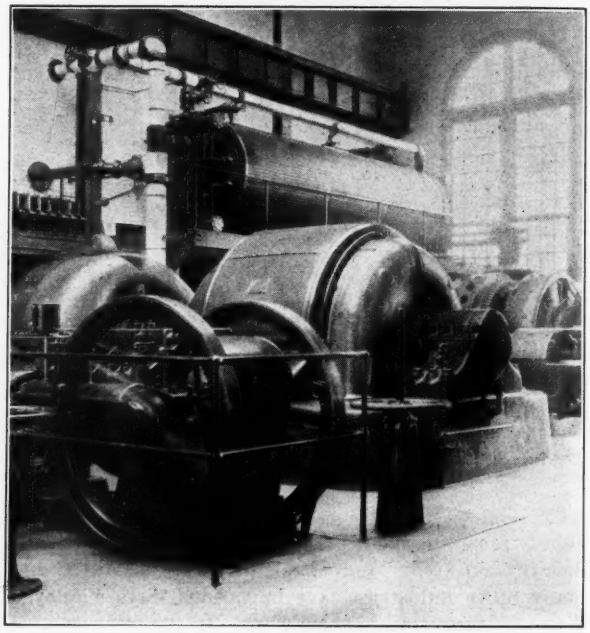
These are only a few of the many industrial applications of refrigeration but they serve to indicate the progress that is being made in the field.

COKING POWER of coal is being studied by the Department of Commerce at the Pittsburgh and Seattle experiment stations of the United States Bureau of Mines. At Pittsburgh, the coking constituents are extracted by benzene under pressure and their properties are studied. At Seattle the strength of cokes produced from different coals under standard conditions is being measured. Recent results of this work indicate strongly that it is the high melting bitumens, solid at room temperature, which contribute most to the strength of coke produced from a coal.

Refrigeration as a Factor in Central Station Design

COMBINED OPERATION of utilities offers certain advantages to both producer and consumer. At Lexington, Ky., the Lexington Utilities Co., of which A. A. Robinson is chief engineer and general superintendent, operates the ice, power and light, street railway and bus lines in the city and have coördinated the various services so as to give them a certain degree of control over the power plant load.

In addition to motor driven ice plants located at strategic sections of the city, they have an 80-t. absorption machine at the power station. The installed generating capacity of the station is 9000-kw. in two 2500



THE ABSORPTION SYSTEM GENERATOR INSTALLED IN A CORNER OF THE LEXINGTON UTILITIES CO. PLANT

and one 4000-kw. units. The absorption unit uses the exhaust from the steam driven station auxiliaries.

Freezing tanks are located in an old ice plant about 100 yd. away, the ammonia being piped over from the power station. At the freezing tanks they have built a 5000-t. ice storage which they fill in winter and draw upon in summer so that the load on the ice plant is practically constant throughout the year.

The ice house is built with double concrete walls 10 in. thick poured with an 8-in. space which is packed with granulated cork. The roof is built with 8 in. of cork under the wood roof and a 5-ft. air space. Sufficient coils are installed on the walls and ceiling to take care of the small heat flow into the storage in order to maintain the proper temperature.

AIR USED to agitate ice cans must be dried to prevent the air pipes from freezing up. This drying is usually accomplished by cooling the air to a temperature below of that freezing tanks so as to condense out a large portion of the moisture.

Good Baffle Walls Save Heat

PROPER ARRANGEMENT, DURABLE CONSTRUCTION, CAREFUL UPKEEP ARE ESSENTIAL. BY W. F. SCHAPHORST

ENGINEERS would be more appreciative of the importance of baffle walls in boilers, if those walls were not completely hidden from view most of the time. The boiler setting seems to be more important because it is continually in full view. If the setting leaks air, the leak is easily found and stopped but, if a baffle wall cracks and leaks valuable hot gases, nothing is done about it until the leak has become serious and expensive. It is regrettable that baffle walls cannot be made visible.

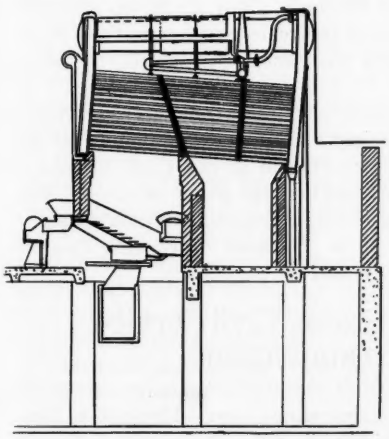


FIG. 1

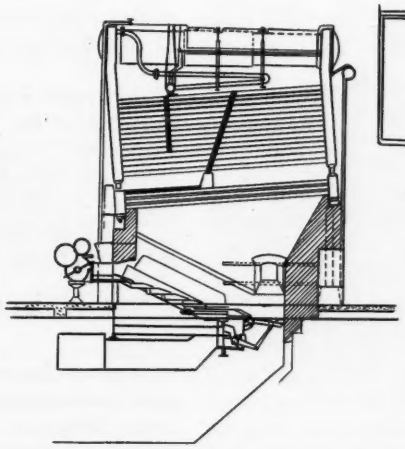


FIG. 2

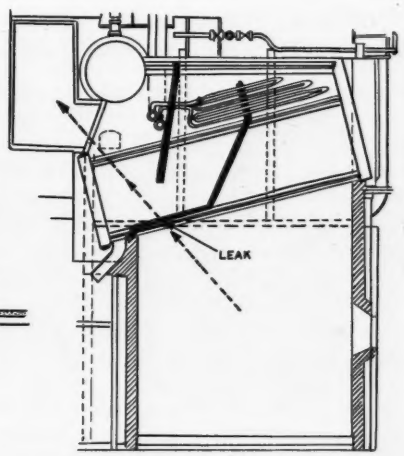


FIG. 3

FIG. 1. ORIGINAL ARRANGEMENT, FURNACE TOO SMALL FIG. 2. SETTING REBUILT WITH AMPLE FURNACE FIG. 3. EFFECT OF LEAK IN FIRST PASS BAFFLE

As a result, many boiler operators and engineers are unaware of the prominent part played by the modern baffle wall as a heat saver. Some engineers think that baffles are merely guides in boilers which compel the gases to flow through a greater distance and across a greater number of tubes. That is partly what they are for, but only a small part.

It is true that the baffle wall is helpless as regards the quantity of air admitted into the boiler. It is also helpless as regards the temperature of preheating. But, after the air once gets into the furnace, it is more or less under the control of the baffle walls, provided those walls are of proper design.

RESULTS OF BAFFLE REARRANGEMENT

Radiant heat, for instance, is largely controlled by the baffle. Thus, in a furnace such as shown in Fig. 1, the volume of the furnace is too small and the tube area for absorption of radiant heat is only one-half of the tube area of Fig. 2, which has properly designed baffle walls. The baffling in Fig. 1 isn't bad; many baffles are worse but the baffling in Fig. 2 is much better.

Boilers shown in Figs. 1 and 2, by the way, are one and the same. Figure 1 was revamped, raised, turned around, a new stoker installed, and converted into Fig. 2. Normal rating was increased from 800 hp. to 1250 hp. A lower grade of coal is burned now, while 13.2 per cent less coal is required per pound of steam. That is real engineering. Baffling is important.

Combustion is bound to be better in Fig. 2 because of the greater furnace volume. Furnaces are seldom if ever too large. Less soot forms on the tubes in Fig 2. The percentage of CO_2 becomes what it should be. There is no slagging. The capacity of the boiler is increased because more heat is absorbed. The efficiency of the boiler is increased because a greater percentage of the heat energy of the fuel is absorbed by the boiler and the chimney gas temperature is less. The properly baffled boiler is superior in nearly every way.

LEAKS CAUSE SERIOUS LOSS

After installation, boiler baffles must be kept tight so that there will be no leakage or short circuiting. Poorly designed and poorly built baffle walls often permit short circuiting as shown by the dotted line in Fig. 3, in other words, the valuable hot gas finds the line of least resistance through the boiler and arrives in the stack before an adequate part of its heat is absorbed. Leaks of this kind are more common than is generally believed, due to poor construction and often the use of improper materials. Sometimes high temperature cement is used in the construction of baffle walls, but baffle walls, as a rule, are subjected to comparatively low temperatures because of the fact that they make contact with the comparatively cool boiler tubes. For that reason, baffles are not much hotter than the tubes themselves. The writer believes that it is better not to use high temperature cement in the construction of baffle walls, as it may not harden properly owing to a low temperature of the wall. Upon washing down the boiler or blowing off the soot, the baffle wall may then

be partly or entirely washed out or blown away. Such things have occurred and the builders of the baffles wondered why.

As already stated, leaks through baffle walls are hard to detect. Holes, cracks and breaks in a baffle wall often cannot be seen because they are hidden by the tubes or by the setting walls. One of the detection methods most commonly employed is to keep tab on the temperature of the stack gas. If the temperature is high, there may be a bad leak through the baffle wall,—the higher the temperature, the more serious the leak.

Diagrams in Fig. 4 show what proper baffling can do in the way of heat saving. The diagram at the left gives the temperature before the baffles were improved, while that at the right shows the temperature after the change. Load conditions were the same when both charts were taken.

Baffles Should Be Able to Yield

Of course, the best way in which to eliminate leaks through baffle walls is to install walls in the first place

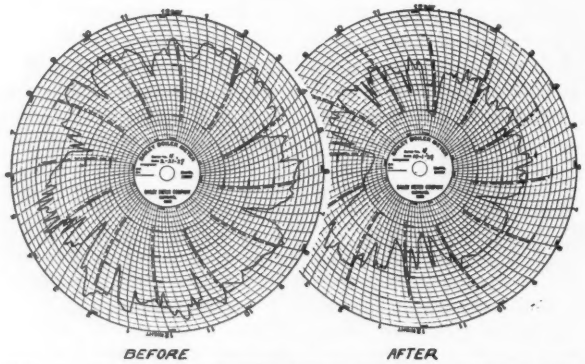


FIG. 4. FLUE GAS TEMPERATURE RECORDS BEFORE AND AFTER OVERHAULING BAFFLES

that do not leak and that will not crack or break. If an engineer insists on installing the breakable variety, the only thing for him to do is to keep the baffle walls in repair from the date of installation, which is difficult to do. To locate a crack or break is not easy and after it is located repair is usually more difficult than finding it.

Attempts to build a solid unyielding baffle wall usually end in a cracked, broken and leaky wall. Because the boiler itself is continually expanding and contracting with change in temperature, forces are set up of sufficient magnitude to disrupt any stiff wall. The proper construction is therefore baffle walls that will yield. All of the leading boiler manufacturers of today, as well as the big users, agree that flexibility in the baffle wall is essential. By installing baffles that expand and contract with the expansion and contraction of the boiler, the possibility of cracking and breaking is minimized.

Maintenance cost of a baffle wall that does not crack or break throughout its lifetime is nil. The wall saves heat when it is new and continues to save the same amount of heat during the life of the boiler. Seldom does a good wall save less than 3 per cent of the annual fuel cost; generally the saving is larger. In cases such as illustrated by Figs. 1 and 2, savings have been as high as 20 per cent and even higher.

A. S. H. & V. E. to Award Anderson Medal

At the 36th Annual Meeting of the American Society of Heating and Ventilating Engineers at the Benjamin Franklin Hotel, Philadelphia, Penna., announcement was made on January 31 of an endowment for a gold medal of award named in honor of F. Paul Anderson, dean of engineering at the University of Kentucky and past president of the society. President Thornton Lewis of the society made the presentation at the 36th Annual Banquet and outlined the regulations under which the F. Paul Anderson Medal would be awarded annually, to the member of the American Society of Heating and Ventilating Engineers, "whose work or services performed in the field of heating, ventilating or air conditioning were outstanding." In making the fund available for this annual medal, it was suggested that the first award of the F. Paul Anderson Medal be made to the member of the society not more than 30 yr. of age who presents the best technical paper during 1930.

Reference was made to Dean Anderson's service as Director of the Society's Research Laboratory at the Pittsburgh Experiment Station of the U. S. Bureau of Mines and his other contributions to the science of heating and ventilating through research investigations.

President-Elect L. A. Harding of Buffalo accepted the presentation on behalf of the society.

United States Civil Service Examinations

United States Civil Service Commission announces open competitive examinations for: Hydraulic Engineer, $3800 to $4400 a yr.; Associate Hydraulic Engineer, $3200 to $3700 a yr.; Assistant Hydraulic Engineer, $2600 to $3100 a yr. Applications for the above-named positions must be on file with the Civil Service Commission at Washington, D. C., not later than March 12. The examinations are to fill vacancies in the Engineer Department at Large, War Department, throughout the United States, and in positions requiring similar qualifications.

Duties of hydraulic engineers will be to undertake, under the general supervision of superiors, studies for the improvement and utilization of rivers for navigation, flood control, power development, or irrigation, or any combination thereof. Duties of associate and assistant engineers will be in connection with the same work. Competitors will not be required to report for examination at any place, but will be rated on their education, experience, and fitness.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or the Secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

Our World Trade, an analysis of the value and volume of principal exports and imports between United States and chief foreign markets, is issued for January to September, 1929, by Foreign Commerce Department, Chamber of Commerce of the United States, Washington, D. C.

A. I. E. E. Discusses Problems at New York

ELECTRICAL ENGINEERS AT ANNUAL WINTER CONVENTION ARE INTERESTED IN NEW CIRCUIT BREAKER, LIGHTNING INVESTIGATIONS, TRANS-OCEANIC COMMUNICATIONS

WITH A DIVERSITY of papers covering nearly every branch of the Electrical Engineering art, with a more than full schedule of inspection trips to industries and projects in the vicinity of New York and with a splendid program of social features, the Annual winter convention of the American Institute Electrical Engineers held at New York the week of January 27th to 31st equalled in interest any of the preceding A. I. E. E. conventions held at the Engineering Societies Building for so many years. The total registration was about 1400.

To electrical engineers this winter convention is always the most important meeting of the year and it rarely happens that one or more important developments are not announced at this meeting. Always, it is a week of intense discussion of the various problems confronting electrical engineers in their work and while these problems do not always permit of immediate solution the interchange of ideas which takes place at this meeting and the sincere expressions of opinion by both manufacturing and operating engineers enable all of them to return to their respective work better fitted to grapple with their problems.

Electrical engineering today has grown too broad in scope to enable any one man having a detailed knowledge of even a small part of the entire field and it is at such conventions as this that the investigator in one branch may learn not only what is transpiring in his own particular branch but also in other branches of the profession. It is in this respect that conventions such as this have a tremendous value.

Although registration commenced Monday morning, January 27, the meeting was not officially opened until Monday afternoon at two o'clock when the convention was addressed by the President, Harold B. Smith. This Monday afternoon session was devoted to a discussion of protective devices. From the standpoint of the power plant engineer this was the session of greatest interest for it dealt with two aspects of electric system operation which have always been of greatest importance, one switching and the other lightning protection.

Last year at this same convention it will be recalled Dr. Joseph Slepian and his Westinghouse associates presented a new form of circuit breaker known as the Deion breaker. This breaker employed the principle of rapid deionization of the arc space formed by the separation of electrical contacts.

This year Dr. Slepian together with B. P. Baker and H. M. Wilcox, all of the Westinghouse Co., presented papers on a further development of this principle incorporating it in an oil circuit breaker. Results of over 2000 short circuit tests with currents ranging from 20 amp. to 15,000 amp. and from voltages of 13,000 to 176,000 r.m.s. across a single pair of contact have demonstrated the effectiveness of this new breaker. The arc energy dissipated is reduced to a fraction of that obtained with the hitherto conventional form of circuit breaker. The duration of the arc for a slow speed (8 ft. per second) circuit breaker in the transmission class of voltages being from two to three cycles. This remarkable performance is obtained by the employment of what is known as a Deion grid around the contacts of the oil circuit breaker. The principles and construction of this breaker will be fully discussed in an article in a subsequent issue.

Monday evening, a joint session was held with the Illuminating Engineering Society on Ultra Violet Radiation. This is an exceedingly popular subject just at the present time and the two papers, one by Dr. Luckiesh of the Lighting Research Laboratories of General Electric Co. and the other by H. C. Rentschler, Director of Research of the Westinghouse Lamp Co., were received with unusual interest. Dr. Luckiesh discussed the possibility of simulating sunlight and outlined briefly the various advances which had been made in the production of light sources rich in those components of sunlight which are deemed beneficial from a biological standpoint. Dr. Rentschler described and demonstrated a new type of ultra violet light meter.

On Tuesday two sessions were held, one in the morning and the other in the afternoon, the morning session being devoted to the general subject of Power System Planning and the afternoon session on various selected subjects ranging from a discussion of the units of the magnetic circuit by A. E. Kennelly to a paper on a cathode ray oscillograph with a Norinder relay. The session on Power System Planning included papers describing the fundamental plans of power supply in Chicago, Detroit and Philadelphia. Since the announcement of the "Synchronized-at-load" system of the New York Edison Co. at the Swampscott meeting last summer, the problem of system connections in metropolitan areas has been of intense interest. While the three systems described at this meeting differ in design, all of them equate themselves into a question of reliability. In the discussion of these papers, Mr. Moultrop, of the Edison Electrical Illuminating Co. of Boston, described briefly the plan used in Boston and Mr. Bang described the system in use on the combined Baltimore and Pennsylvania Water Power System. E. C. Stone of the Duquesne Light Co. contributed to the discussion by outlining the features incorporated in the Pittsburgh System. Both in Boston and in Pittsburgh the problem of system connections is taken care of not by an individual, but by a committee on system development or system planning.

Lightning investigation was the general topic of the session on Wednesday morning and eight papers presented at that session discussed the lightning problem on transmission lines from every possible angle. Investigations in lightning are being conducted on a number of different power systems throughout the country and gradually a vast amount of data is being accumulated which, when it is subjected to a statistical

analysis later on, will undoubtedly yield information of great value in overcoming trouble due to lightning disturbances. While the lightning proof line is still the electrical engineer's dream, indications are that this dream may be realized within a very few years. No papers were scheduled for the afternoon of this day, the time being given over almost entirely to inspection trips.

Wednesday evening was the occasion of the Edison Medal presentation to Prof. Charles F. Scott of Yale University. This medal, which is awarded each year, by the Edison Medal Committee of the A. I. E. E., was presented this year to Prof. Scott for his contribution to the science and art of polyphase transmission of electrical energy. Prof. Scott, who began his electrical career with the Westinghouse Co. at East Pittsburgh, was associated first with Tesla and later with Lamme in the development of the polyphase induction motor. He is also the originator of the Scott connected transformer for transforming two to three phase or vice versa.

Trans-oceanic communication was the subject of the session on Thursday morning and its five papers, one on submarine telegraphy and four on trans-oceanic radio telephone service, were received with great interest. The development of submarine telegraphy it was shown in a paper by I. S. Coggeshall had developed hand in hand with its more modern sister, "trans-oceanic radio" and today they have many things in common. They employ similar equipment at both the sending and receiving ends and except for the difference in the media through which transmission is effected there is little difference between the two systems.

In the four papers on trans-oceanic radio telephone service was shown the tremendous development in this class of service during the 2 yr. it has been commercially available. Trans-oceanic radio telephone service is now available 24 hr. a day and with the addition of three new short wave channels operating on about 16, 22 and 33 meters the reliability of transmission has been greatly improved. The basic rate from New York to London is at present $45 for three minutes with slight additions for extensions in Europe or America. The initial rate of $75 was reduced to the present level on March 4, 1928 and this was of course responsible for some growth in the business. Since 1927 the average number of messages per day has increased from 13 to 45 last May.

Thursday afternoon was given over to the only two simultaneous meetings which were held during the convention. Both of these convened at 2 p. m., one dealing with the general subject of dielectrics and the other on electric welding. As usual, in connection with any session on dielectrics, the name of J. B. Whitehead is prominent. Mr. Whitehead's investigations on dielectrics have for many years been of extreme importance to the electrical industry and his papers are always looked forward to at the winter convention. In this case Mr. Whitehead, together with R. H. Marvin, both of John Hopkins University, presented a paper on the conductivity of insulating oils. Experiments on the charging currents and associated phenomena in transformer oil were described. The charging currents remaining after the elimination of the initial transient were studied to within a few hundredths of a second of the application of continuous voltage. Two samples of the same oil obtained at different times differed radically. The existence of space charges in the charged oil was shown and the time of formation of these charges together with the resulting non-uniform distribution of voltage was measured. The importance of the charging current in its early stages was emphasized since it is the initial conductivity which determines the alternating current loss.

The last day of the convention was devoted entirely to a discussion of electrical machinery. The morning session included papers on the operation of transformers and on the telephone interference of alternating current generators feeding directly on the line with grounded neutral. The afternoon session was devoted entirely to a discussion of the problems involved in the design of motors and generators.

The above is a brief discussion of the technical features of the program. As already mentioned, there were elaborate plans for inspection visits, those proving of greatest interest being the trip to the Sperry Gyroscope Corporation, the Short Wave Trans-Atlantic Radio Transmitting Station of the A. T. & T. at Lawrenceville, New Jersey, and that to the Roseland Switching Station of the Public Service Electric and Gas Co. Social events included a dinner and smoker held at the Engineering Society Building on Tuesday where, through the courtesy of the Radio Corporation of America, the General Cable Co., the National Broadcasting Co. and others, an evening of real entertainment was had. Phillips Carlin, the well known broadcast announcer, acted as master of ceremonies. As has been customary for several years, a lecture on a non-electrical subject was a feature of this meeting. Immediately after the presentation of the Edison Medal, Dr. David M. Robinson, Professor of Archaeology at Johns Hopkins University, gave an illustrated lecture on the discovery and excavation of Olynthos.

ONE OF THE FEATURES of the General Electric display at the International Heating and Ventilating Exposition held recently in Philadelphia was a smoke detector that may be used for fire prevention. The smoke detector on display is a laboratory model, and illustrates the application of the photoelectric tube that is now being made experimentally in the Hudson tube, connecting New York and New Jersey. In the tube, the smoke detector or visibility meter, as it is there called, is placed in the exhaust duct. If the exhausting smoke becomes dense, the photoelectric tube gives warning and attendants put additional exhaust fans to work.

The device shown in Philadelphia consists of a long glass tube. In one end is a light source and in the other a photoelectric or light sensitive tube. A small opening in the glass tube permits the operator to blow smoke inside the chamber. When the light intensity is dulled by smoke, the photoelectric tube responds, throwing a relay which starts an exhaust fan. The fans continue in operation until the atmosphere within the chamber is cleared. The same device may be utilized for fire detection, in which case the relay operates a buzzer or bell instead of the fan.

New Steam Plant for University of Chicago

BOILER PLANT DESIGNED FOR FUTURE EXPANSION OF THIS GREAT INSTITUTION SUPPLIES HEATING STEAM THROUGH 5000-FT. PIPE LINE

AT A JOINT MEETING of the Chicago Section of the A.S.M.E. and the Western Society of Engineers held in Chicago on January 27, Edward P. Rich, of Neiler, Rich & Co., described the new steam plant for

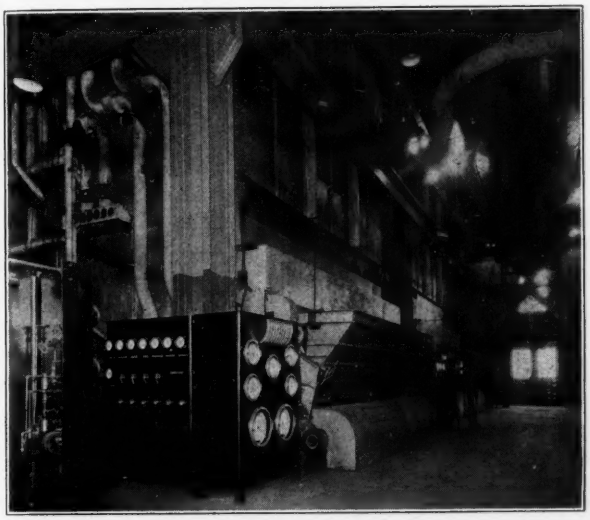


FIG. 1. BOILER ROOM OF NEW STEAM PLANT FOR THE UNIVERSITY OF CHICAGO

the University of Chicago of which they were the consulting engineers and presented the initial costs and operating data.

During the past few years, a number of large buildings have been added and by the end of 1931 it is estimated that the cubical contents will be about 51,000,000 and in 1945 this estimate will approach 69,000,000 cu. ft. Estimate of the probable load requirements for the intervening years is as follows:

Season	Cubic Contents	Boiler Hp.	Max. Demand Kw.	Yearly Current Kw-Hr.
1931-1932	50,817,340	8470	2033	6,890,000
35- 36	56,032,640	9340	2241	7,600,000
40- 41	66,492,640	11,000	2660	9,030,000
44- 45	67,992,640	11,330	2720	9,230,000

While space is being allowed for the installation of four boilers, only three have been placed. The structure covers an area of 95 by 100 ft., the main portion 80 ft. high with a 110-ft. high tower section provided with an elevator. Galleries are provided at various levels for supporting economizers, air preheaters and induced draft fans.

Water walls, soot blowers, superheaters, economizers and air preheaters are provided. The boilers are of the four-drum Heine V-type designed to operate at 300 lb. pressure, each having a total heating surface, exclusive of water walls, of 12,040 sq. ft.

Stokers of the forced draft chain grate type are used. The total furnace width is 21 ft. and the active grate length 14 ft., while the effective grate area is 280 sq. ft. The stokers are operated by motor drive through variable speed transmission which is regulated by means of the combustion control. The superheaters are of the bare tube type guaranteed to develop 150 deg. superheat with steam at 250 lb. pressure. The economizers are of the protected tube type each having 3360 sq. ft. of active surface and a capacity sufficient to take care of 170,000 lb. of gas at 700 deg. temperature.

Each boiler is equipped with a separate air preheater of the plate type, having a total heating surface of 10,080 sq. ft. Each stack has a total capacity of approximately 8000 hp. Both are of the streamline type, 10 ft. dia. at the top, 150 ft. high and so designed as to permit of a 50-ft. extension.

Coal is received from a reënforced concrete railroad trestle, adjoining the property, which is of sufficient length to permit dumping five cars of coal at one time.

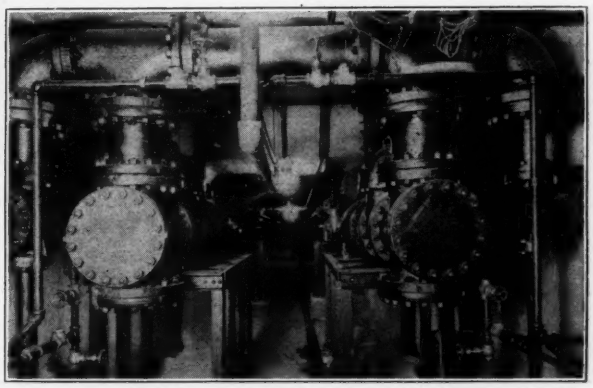


FIG. 2. LOOKING SOUTH FROM THE NORTH END OF THE HEATING PIPE TUNNEL

Ash is delivered directly into a car from an overhead ash storage bin located in a corner of the building.

Overhead bunkers have a capacity of approximately 1500 t. A conveyor tunnel 10 ft. wide by 7 ft. high extends below grade for the total length of the concrete trestle and a belt conveyor discharges on a lateral pan conveyor which in turn feeds the crusher.

Tests made of the return water indicate that the oxygen content varies from 2 to 3.32 c.c. per litre. Installation of deaerating heater units in the 8-in. return line to the power house was not found practicable, therefore this line was made of extra heavy genuine wrought iron in order to increase its life. From two 3000-gal. return tanks the condensate flows to a 10,000-hp. Cochrane open cast-iron deaerating feedwater heater. The water then flows to centrifugal turbine-driven boiler feed pumps and is passed through a Henszey continuous blowdown system to the economizer section of the boiler. Makeup water, which at times is as high as 30 per cent, is conditioned by means of a hot process softener having capacity of approximately 10,000 gal. per hr.

Steam transmission is accomplished by means of a reënforced concrete tunnel approximately 5000 ft. long which is 8 ft. wide and 7 ft. high. Expansion pipe areas are provided every 300 ft. in the tunnel run. The piping system was designed for an initial steam pressure of 150 lb. in order to reduce the required size of the high-pressure steam piping. With 150 deg. superheat at the power house the steam is free from condensation upon entering the heating area.

Two 12-in. high-pressure lines of welded extra heavy steel piping installed in the tunnel are each capable of delivering 150,000 lb. of steam at an initial pressure of 150 lb., the drop being approximately 1.5 lb. per 100 ft. Fittings, where used, are of steel and Sarlun joints are used on all flanges.

Anticipating the possible installation of a generating plant to serve the entire electrical needs of the University, the boilers were designed to operate at 250 lb. pressure and a 150-deg. superheat.

Construction costs for the power plant and tunnel do not include the price of the property or the engineering fees. Tunnel construction cost includes such renewal and replacement necessary to return all property to the original condition.

Power Plant Building

For complete Power House Building including bunkers and boiler foundations $353,000.00
950,000 cu. ft. at $.37 per cu. ft.
Coal Tunnel and Track Structure: Complete track structure with coal tunnel including wood trestle connection to Illinois Central Right-of-Way $66,000.00
Reservoir: 90,000 gal. concrete water storage reservoir $11,000.00

Steam Transmission

Reënforced Concrete Tunnel: 5000 ft. at $90.00 per ft. $450,000.00
Transmission Piping: Complete with cross connections, bilge and return pumps, two 12-in. high-pressure mains, one 8-in. condensate line and two 3-in. drip lines $205,000.00
5000 ft. at $41.00 per ft.
Covering: Nonconducting insulating covering for all steam, water and drip lines including painting $65,000.00
5000 ft. at $13.00 per ft.
Wiring: Wiring for light and power for pump operations $10,000.00
5000 ft. at $2.00 per ft.
Total cost for transmission line, including concrete tunnel, piping, covering and pumps $730,000.00
5000 ft. at $146.00 per ft.

Cost of Mechanical Equipment for Power House

Boilers, stokers, water walls, brickwood, arches, insulation $190,000.00
Superheaters, economizers, air preheaters and stack bases, stack lining, forced draft fans with turbines, breeching and air ducts $125,000.00
Coal and ash handling, ash cars and track, stoker hopper, ash chutes to Peck carrier $48,000.00
Piping, covering, air ducts, breeching and miscellaneous $166,000.00
Air compressor, feedwater heater, water softening plant $19,000.00
3—Boiler feed pumps, washout pump, service pumps .. $13,000.00
Scale and tanks $6,000.00
Combustion control and measuring instruments $24,000.00
Wiring transformer vault, transformers, light and power $24,000.00
Two steel stacks $6,500.00
Total for Mechanical Plant $621,500.00

Operating Data Boiler No. 1, Jan. 20, 1930

Average load 80,416 lb. per hr. 223 per cent of rating, Average run 6 hr.

DRAFT READING	
Stoker Compartments	Inches of Water
1	+0.7
2	+1.33
3	+0.32
4	0
5	0
Overfire Air	0.057
Boiler Uptake	—0.31
Preheater Inlet	—0.99
Preheater Outlet	—1.9
CO_2 Average	11 per cent

TEMPERATURE READINGS	
	Deg. F.
Economizer Gas Inlet	495.5
Preheater Gas Inlet	389.3
Preheater Gas Outlet (Stack Gas)	252.8
Preheater Air Inlet	101.8
Preheater Air Outlet	260.1
Feedwater	200.0
Economizer Water Outlet	274.0
Steam Temperature	526.0
Superheat	160.1
Steam Pressure Ave.	150.0 lb.

Mechanical Cleaning of Boiler Tubes

By W. E. Warner

IN COURSE OF TIME, the tubes of water-tube boilers may become clogged with deposit which impedes the water circulation and interferes with heat transmission between the water and furnace gases.

Mechanical tube cleaners are effective in removing these deposits and may be operated by either water, air or steam. The apparatus consisting of a motor, driven by one of the former mediums, and a revolving cutter head or vibrating hammer which is forced through the tubes.

Where the motor is driven by water, the efficient operation is dependent to a considerable extent on the water pressure, so a pressure gage should be fitted on the inlet side of the water motor to show the water pressure delivered to the machine.

Pressure required is usually somewhere between 100 and 125 lb. per sq. in. In many cases, a considerable friction loss is encountered through the connecting hose which is sometimes too small or may have restricted passage, so that although sufficient pressure may be applied at the water main, by the time it reaches the tube cleaner it is so reduced in pressure that it cannot perform rapid work.

Another cause of trouble is through water containing dirt, chips or cinders which clog various ports in the machine. When the machine is not in use, it should be well oiled or stored in oil to keep it from rusting. Cutters should be pressed gradually into the scale and not forced as this may cause jamming. Air or pneumatic scalers are also widely used. These are driven by air supplied along an air hose from a compressor designed to give the requisite amount and pressure of air. One cause of trouble with these cleaners is through the air pressure being either excessive or insufficient, the pressure supplied to the cleaner being readily adjustable by means of the air valves on the supply line.

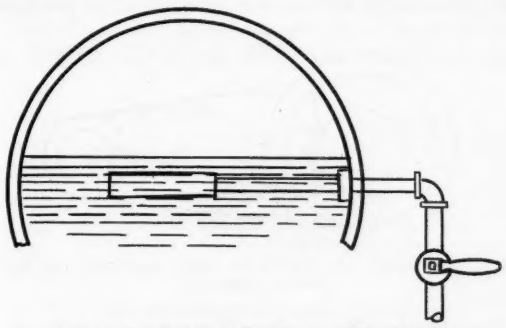
Before connecting the machine to the air hose, the latter should be well blown out with air to remove any grit or dirt that may be present. Cutters should be fed into the tubes gradually but should be kept continually cutting the scale. This is indicated by the noise made by the cutters. When the cutters have advanced some 6 in. into the tubes, a water hose should be turned into the tube to soften the scale and prevent dust entering the boiler room, the water hose following the cutter through the tubes. A sight-feed lubricator, fitted to the air line, lubricates the moving parts of the air motor, ordinary machine or lard oil being satisfactory for this purpose.

Steam tube cleaners are available but are not as widely used except where compressed air or water are not available. This is due largely to the difficulty of handling the exhaust steam and danger of the operator being scalded if a steam line should burst or a serious leak suddenly occur.

With all tube cutters, it is important that each cutter be kept sharp and that the machine be so operated that the metal of the tubes is not cut or damaged, as surface marks on the tubes might form a starting place for corrosion.

Boiler Blowdown

A BOILER should be blown down only when it is under pressure. If there is no pressure, the water will simply run out, carrying only a small amount of sediment which has been deposited around the blowoff connection. Likewise it will do little good to blow down



SURFACE BLOWDOWN ARRANGEMENT

a boiler while it is under high forcing, as the water in this case is in a state of violent agitation, so that solids present in the water will be held in solution and only a small amount will be blown out.

Blowdown should occur, if possible, when the load is light as the fires will not be over hot and little steam will be formed. If the blowoff is opened at such a time, more sediment will be blown out. It should also be remembered that the blowoff will not remove all the mud, sediment or scale-forming matter. When the blowoff is opened, the water rushes towards the pipe from all parts of the boiler and accumulation of mud and scale at the front end of the boiler will be little disturbed. In other words, the blowoff is rather inefficient as a means of removing mud and similar deposit from a boiler.

If a considerable amount of solids is in suspension in the water, the blowoff should be opened at least every 24 hr. or even once during each watch. The blowoff should be opened wide for a short time, not kept open a small amount for a long time, as such procedure may choke up the valve or cut the seat and cause leakage. A good way to blow down a boiler is quickly to open the blowoff cock wide, then close it quickly, after which the operation should be repeated. By this means, a counter agitation of the water is set up. Before blowing down, the water level should be raised about 2½ in. above normal. The length of the intervals between blowdowns must be determined after noting the amount of deposits in the boiler at the time of cleaning.

If a surface blowdown be fitted, in addition to the bottom blowdown apparatus, it will be found to assist in getting rid of scale-forming matter. Oil and fine particles of scale-forming matter float on top of the water and can be removed by surface blowing before they settle and are deposited as scale on the heating surfaces of the boiler. The surface blow should consist of a shallow pan, placed just below the regular water level and supplied with a pipe leading from a point near the bottom of it. This pipe being fitted with a cock, should pass through the boiler shell to a sewer or other convenient point where the scum may be disposed of. The body of water in the pan will remain quiet, while the circulating water will form an eddy on its surface, which will cause the scum to gather over the top of the pan and, as the water is quiet in the pan, the scum will settle gradually in it and remain as mud until it is blown out through the surface blow cock. Before using the surface blow, the water in the boiler should be raised a couple of inches above the usual level. Removal of scale-forming matter by this means will more than pay for the heat wasted by use of this apparatus.

Brooklyn, N. Y. FRANCIS V. GREENE.

Large High Speed Generators

IN YOUR DECEMBER 15 issue, you published an interesting article entitled "Large Units Continue to Mark Generator Progress" and on page 1366, reference is made to a unit installed at the Brimsdown Station of the North Metropolitan Electric Power Supply Co. as representing the highest capacity developed so far at speeds above 1800 r.p.m.

It may be of interest for you to know that a turbo alternator having a capacity of 45,000 kv-a. at 12,500 v., operating at 3000 r.p.m., was recently placed in operation by Brown Boveri & Co. in Germany; also, that they have several other large units either in operation or in the course of manufacture. Some of the outstanding installations are as follows: One 31,250 kv-a., 36,000-v., 3000-r.p.m. alternator—Landerbruget Station, in Flanders, Belgium; two 40,000-kv-a., 10,500-v., 3000-r.p.m. alternators—Poland; one 40,000-kv-a., 10,500-v., 3000-r.p.m. alternator—Brussels, Belgium; three 37,500-kv-a.,

7000-v., 3000-r.p.m. alternators for Buenos Aires, Argentine.

All of the above-mentioned turbo alternators are direct connected to Brown Boveri 3-cylinder turbines operating at 3000 r.p.m., which, for reasons of their high economy and absolute reliability, are in extensive favor practically everywhere. It may be of further interest to note that units of much larger capacity operating at 3000 r.p.m. are contemplated for future installations.

Camden, N. J. AMERICAN BROWN BOVERI CO., INC., WM. JORGENSEN.

Heavy Fuel Oils for Diesel Engines

EXPERIENCE has shown that heavy tar oils, such as are obtained from gas retorts and coke ovens can be used successfully in Diesel engines, any troubles in their use being largely brought about by using them under improper conditions.

Any oil that will conform to the following specifications can be used. The oil should contain not more than 2 per cent of solid constituents insoluble in Xylol. The ash content should be not over 0.1 per cent, the water content not over 2.5 per cent and the coking residue not over 3 per cent. The oil should be liquid when at 60 deg. F.

Tar oil, obtained from gas works, contains more or less finely divided coke and any heavy oil can carry a large amount of solid impurities in suspension, so, if these oils are passed through a centrifugal filter before use, a lot of trouble caused by deposits in the cylinders will be avoided. These impurities consist of finely divided solid matter, tank scale and moisture, any of which will cause trouble if carried into the cylinder.

Good combustion is more easily secured in a hot engine but, owing to difficulties in vaporization, combustion is generally imperfect when starting. This makes it inadvisable to start on these oils and light oil should be used for this purpose. Light oil should also be fed a few minutes before stopping in order to clear the tar oil out of the pipe work.

Sometimes a pilot jet is so fitted to the engine as to inject a small amount of light oil just in advance of the main fuel supply; this assists combustion at all loads, the amount of light oil injected being about 7 per cent of the total. A hot air blast for injecting the fuel is beneficial. This has been secured by cutting out the last cooler on the compressor but that is considered dangerous, unless operation is kept under constant supervision. Heating the oil before delivery to the fuel valve is also advantageous.

Where heavy oil is used, there is slightly more wear on the valve gear and it is necessary to clean the valves twice weekly, also regrind the exhaust valves weekly. As tar oils have a slight corroding action on brass and to a lesser degree on copper, the fuel piping and valves should be of cast iron or steel. Deposits on the piston head will be little in excess of those found when using lighter fuel oils, provided the heavy oil contains no considerable suspended solid matter and has a coking residue not in excess of 3 per cent.

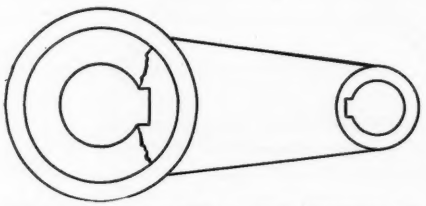
Essentials for success with heavy fuels are: Filtering the oil to remove any suspended solid matter and moisture; maintaining the cylinder compression by avoiding stuck and leaky piston rings or valves; avoiding light loads and starting and stopping on light oil.

Brighton, England. W. E. WARNER.

Dashpot Arm Crack Repaired by Shrunk Steel Ring

UPON DRIVING up the key in the loosened dashpot-rod crank-arm of a Corliss engine, the hub was found to be badly cracked. Shutdown of the engine, which drove a paper machine, longer than necessary meant loss of a lot of product and there were no such animals as spare power units or emergency power sources around the mill.

This was a fine situation. Monday morning. No chance to stop for any length of time until Sunday without losing production. Cracks so located that the arm would likely break any time. Evidently a temporary quick repair must be made. A steel ring was, therefore, turned up, the inside diameter being a few thousandths of an inch less than the outside diameter of the crank arm. Means for heating the ring were arranged near the engine and the chance watched for a 5-min. shut down without too much harm to production.



ARM CRACKED AT KEYWAY AND SHRUNK ON RING FOR REPAIR

Having the ring already heated to a dull red, as soon as the engine stopped, the ring was driven over the hub of the arm, as shown in the illustration, and the engine was off again.

When the arm was taken off the following Sunday for replacement, the key was so tightly wedged that it was almost impossible to move it. Had it not been necessary to remove the valve stem and dashpot rod to repair them for wear, the old arm could have been run indefinitely.

Valve stem and dashpot rod were built up by welding, then turned to the proper diameter, keyways cut and they were as good as new, all at little cost and in a minimum of time.

Turners Falls, Mass. WILLIAM W. WHITE.

Change of Setting Avoids Destruction by Heat

BURNING OUT door liners and brick fronts in a 72-in. by 18-ft. return tubular boiler in our plant had become a regular frequent and costly occurrence. The boiler had been known to be a hard steamer and, even when forced, only 200 hp. could be obtained from it. It had a furnace 66 in. wide and was fitted with an underfeed stoker which was set with a 38-in. clearance between dead plates and boiler shell. The bridge wall was straight across the top and at the center had an 18-in. space between the top of the wall and the boiler shell.

In trying to force this boiler beyond what it had ever done before, the liners were melted off of the furnace doors, part of the brick work was melted down and a 12-in. dia. bag, which projected down 7/8 in., developed about 14 in. from the front tube sheet. The bag was driven back, the other parts were repaired and the boiler was fired up again, after which 16 rivets were found to be leaking in the first girth seam.

This is a three-pass boiler, with the first girth seam directly over the bridge wall. To replace the rivets, the bridge wall had to be torn out. When it was rebuilt, a clearance of 24 in. was left between the top of the bridge wall and the bottom of the boiler. No brick work has been melted out since nor have door liners burned up, yet I believe fully 450 hp. has been carried by this boiler for periods of 2 hr. since the change was made. It is now worked continually at 200 per cent with more ease than when developing 130 per cent before.

Minneapolis, Minn. FRED S. RUTLEDGE.

Guard for Automobiles Increases Parking Space

ONE EDGE of the parking area reserved for employes of a western power plant was on top of a steep river bank. Rather than go too close to it, employes stopped and parked a good distance back, leaving a great deal of unused space as a matter of precaution and safety. As space became a premium and the use of all the area imperative, the need of making this section as safe as the rest became pressing. The photos and sketch show a firm, sturdy and almost immovable railing or barrier constructed of material no longer of use for its original purpose.

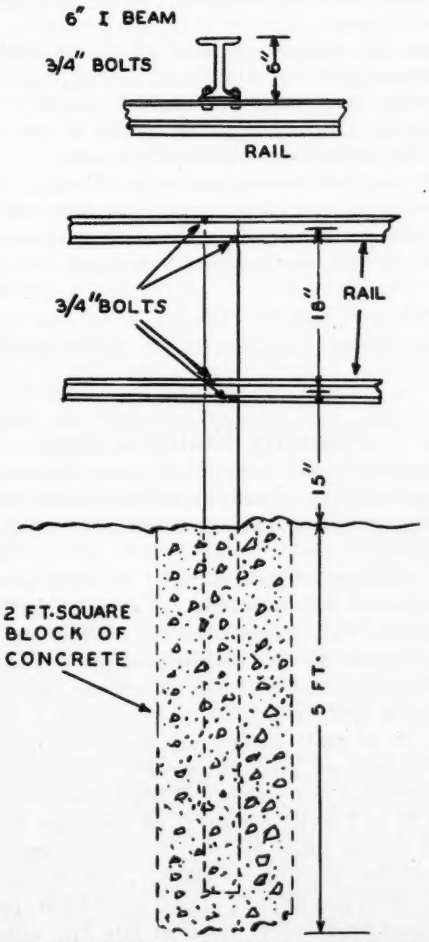


FIG. 1. CONSTRUCTION OF FENCE FOR GUARD SHOWING HOW THE I BEAMS ARE SET IN CONCRETE

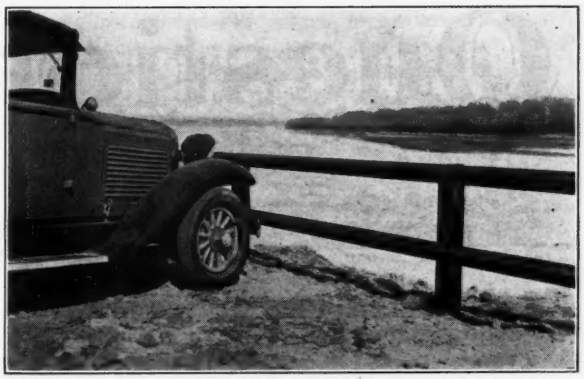


FIG. 2. FINISHED FENCE IS RIGID ENOUGH TO STOP ANY CAR AND PREVENT FALL INTO RIVER BELOW

Old 6-in. I beams were set as posts in 2-ft. squares of concrete about 4 or 5 ft. in the ground, these beams being set about 9 ft. apart. Old railroad rails were then securely bolted to the beams, the first beam center being 15 in. from the ground and the other rail center 18 in. higher. The rails were bolted to the beam flanges with 3/4-in. bolts. Practically no bend or break is possible. Due to the height given to the first rail, the wheels of cars striking it can not wedge under or rise over it. The cars, big or little were easily, simply and safely stopped.

Missouri Valley, Iowa. FRANK W. BENTLEY.

Corn Cobs Used as Filtering Material

CORN COBS, from which the corn had been removed, were collected and stored in a dry location by an engineer at a canning factory and after thorough drying were used successfully by him as a filtering agent in an open heater.

Dried cobs were placed in the filter chamber until it was filled, perforated iron sheets being placed on top of the cobs to prevent them from floating before they became water soaked. Even after the cobs became water soaked, their ability to absorb oil was unimpaired. It was also found that chemical matter boiled out of the cobs acted as a scale removing agent inside of the steam boilers. Whether or not this chemical action is detrimental to the boiler, I do not know but no apparent trouble developed from this source. Care had to be used to prevent any part of the cobs from getting into the suction pipe but this precaution would have to be taken for any other loose filtering material.

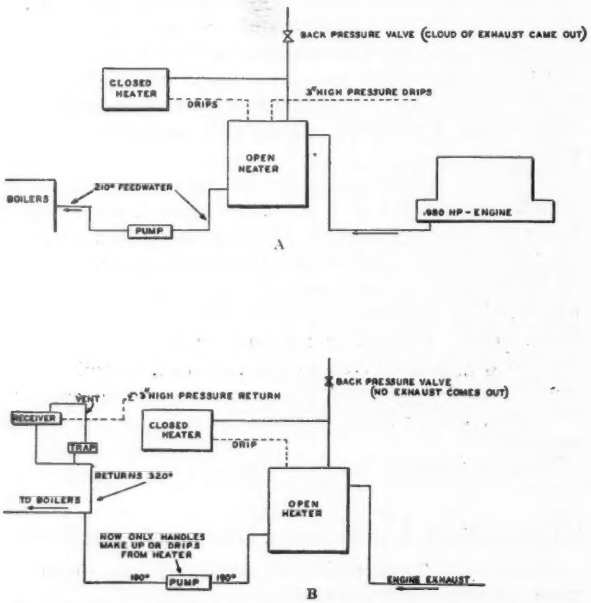
Toronto, Canada. JAMES E. NOBLE.

SOME ENGINEERS thoroughly tin all bearing boxes before pouring the babbit. The shell is then heated to the temperature of the molten babbit before pouring. Afterward it is cooled slowly so as to avoid temperature strain between the two metals.

Questions and Answers

Unusual Savings by Change in Installation

UNUSUAL HEAT SAVINGS have resulted from a change made in our laundry plant. I have tried to figure them out on a B.t.u. basis, even taking into consideration the amount of steam used by the pump, but cannot account for the large gain made and so would be glad to have others' opinion on the matter.



ADDITION OF HIGH-PRESSURE TRAP EFFECTS SAVINGS: A. INITIAL INSTALLATION WITH FEEDWATER TEMPERATURE AT 212 DEG. B. CHANGED ARRANGEMENT, TRAP AND RECEIVER FEEDING HIGH-PRESSURE CONDENSATE TO THE BOILER AT AN AVERAGE TEMPERATURE OF 320 DEG.

Equipment of the plant includes a 225-hp. h.r.t. boiler and a uniflow steam engine from which exhaust goes into an open heater, thence into a closed heater. All high-pressure condensate from traps formerly went to the open heater as shown at A in the illustration. Temperature of feedwater was 210 deg. and the average coal consumption, 28 t. of soft coal per week, hand-fired. Average run of boiler is 50 hr. a week.

After changing the arrangement as shown at B, all high-pressure condensate is run from the heater to a boiler feeder or return trap which is vented back into the receiver above the trap, this condensate going to the boiler at a temperature of 325 deg. The amount of this high pressure condensate handled by the boiler feeder is approximately 4050 lb. per hr. out of a total of 6750 lb. per hr., the boiler feed pump handling the balance or 2700 lb. Average steam pressure carried is 110 lb. gage.

No heat exchanger, or "preheater" as they are known in laundry practice, is used, as will be seen from the illustrations. In the change made, all we did was to take about 4050 lb. of condensation which left the machines at about 330 deg. and, instead of sending it to the open heater, where all water above 212 deg. flashed into steam, we returned this condensate at 320 deg. to the boiler by a return trap. By doing this, we eliminated the need of the pump formerly used to handle this water, hence saved 90 per cent of the steam required since the return trap uses only 10 per cent of that amount and this exhaust steam from our machine, which is at full boiler pressure, is introduced into a closed receiver and condensed. The pump is 7½ and 5 by 6 in. and is now used only to handle make-up or drip from the open heater.

Since the change indicated in the illustration, the coal consumption is only 22 t. a week, while before making the change the consumption was 28 t. a week, representing a saving of 6 t. or almost 25 per cent. At times, this saving is as high as 42 per cent.

Why are the savings so large, when a feedwater temperature rise of 11 per cent is usually considered as representing a saving of only one per cent in coal and our rise in feedwater temperature is only 115 deg.?

H. W. B.

Editor's Comment: Discussion by our readers of the heat savings indicated in the above description is desired.

Standby Boiler Losses

HOW MUCH FUEL is required to keep steam pressure up in an ordinary water-tube boiler of about 500 or 600 hp. This should include such steam as is required by auxiliaries. T. H.

A. Amount of fuel required to carry a boiler on banked fires is approximately the same as that required to maintain full steam pressure. Some approximate figures of tests for this requirement are as follows:

A hand-fired boiler of 640 (rated) hp., using W. Va. bituminous coal, on a 72-hr. test, required 1 lb. of coal per sq. ft. of grate surface per hour, or approximately 0.2 lb. of coal per rated horsepower. This was the best figure obtained in a number of trials, the average being from 1.25 to 1.50 lb. per sq. ft. of grate per hr. or 0.25 to 0.30 lb. per rated hp. per hr. These figures would indicate that banking, a 600-hp. unit would require between 3000 and 4000 lb. of coal for a 24-hr. period.

A hand-fired boiler, rated at 604 hp., using No. 3 anthracite buckwheat, required approximately 0.33 lb.

of coal per rated hp-hr. or 4800 lb. for 24 hr. A stoker-fired boiler rated at 600 hp. required 8000 lb. of coal for a period of 24 hr. or 0.55 lb. per hp-hr. This figure is probably higher than will ordinarily be found necessary.

As above noted, the lay-over losses are those usually found with reasonably tight ash pits and proper damper regulation. With powdered fuel, the stand-by loss just to hold steam pressure, is approximately 0.1 lb. of coal per rated hp.

Exact quantity of oil fuel required for maintaining full pressure is difficult to determine. Two per cent of the fuel ordinarily used in generating a boiler's rated capacity will maintain the full steam pressure for an indefinite period. This 2 per cent, however, does not represent the total stand-by loss, since, during lay-over periods, the setting is cooled and on taking a load again, the rate at which oil is burned will, for a period after starting, be considerably in excess of that rate when the setting has been brought up to its normal operating temperature.

Briquets as Fuel

TO WHAT EXTENT are briquets used as fuel, what possibilities are there in this direction and how are they made? W. S. M.

A. While 10 per cent of Germany's total coal production is marketed in the form of briquets, in the United States it appears that the expense of briquetting makes it difficult frequently for this form of fuel to compete with the relatively cheap, high grade coals that are available. As our best coal seams become depleted, however, briquetted fuel will become of more importance.

The term "briquet" includes compressed fuel made from coal, lignite, peat, or coke, either with or without binder. Briquets are mostly machine made, the fine coal being mixed with a binder and the resulting mixture subjected to a high pressure (from 1800 to 3000 lb. per sq. in.) in a roll press. In some instances, a part of the volatile matter of the coal and the binder is driven off by a mild baking. This is done to produce a more nearly smokeless fuel and to give a harder, less friable briquet.

Briquets are made in various sizes and shapes. Large rectangular briquets weighing up to 7 lb. are quite extensively used in Europe. They occupy from 10 to 20 per cent less space for storing than lump coal but have the disadvantage of requiring labor to break them before firing. In the United States 1¾ to 2½-oz. briquets are used for domestic heating and the 2½ to 5-oz. sizes are used for industrial purposes. These briquets are usually either egg-shaped or of the "overstuffed pillow" shape (i.e., with rounded edges) to minimize breakage. The rounded edges have the further advantage of permitting good air circulation and therefore aiding combustion.

Good briquets should be as hard and break as little during handling as anthracite coal. They must not deteriorate on weathering and they should be practically waterproof. To meet these requirements, the proper binder must be used. Asphalt pitch and pitch made from coal tar or water-gas tar are the customary binders and give good results, particularly when the volatile and objectionable creosols are distilled by a preliminary treatment. Various natural hydrocarbons, such as gilsonite, molasses, starch, or dextrin pastes and sulphite liquor (a by-product in the manufacture of wood pulp by the sulphite process) also have been successfully used. Usually from 5 to 8 per cent of binder is required to make a hard, durable briquet.

Anthracite, semi-bituminous and bituminous coals and carbo-coal (a coke left from the low temperature distillation of coal) have been successfully briquetted in the United States. Lignite and peat briquets, although quite widely manufactured in Europe, have not been produced to any extent in America.

Crushed semi-coke, or coal mixed with by-product pitch and formed into pillow-shaped pieces about 1½-in. square, weighing about 1½ oz. under a pressure of 2000 to 4000 lb. per sq. in. burns well, having most of the excellent combustion properties of semi-coke but it gives off an objectionable smoke due to its pitch binder. If some binder material were available at a low price which would yield a briquette as strong physically as the pitch-bound briquette and which were smokeless, the process could be stopped at the second stage. The raw briquette could then be sold as such and would be an excellent artificial anthracite. But, unfortunately, such binder material is not to be found at a cost within the economic limits of the process.

Briquetting machines are now obtainable from a number of manufacturers located in different parts of the country. You will find a chapter on "Fuel Briquets in 1927" by Tryon and Corse in "Mineral Resources of the United States," a bulletin published by the Bureau of Mines and sold at 5 cents a copy by the Superintendent of Documents, Washington, D. C.

Power Engineering Factors

WHAT IS MEANT by the following terms as used in power plant practice and how do they differ from one another? Load factor, power load factor, diversity factor and demand factor? H. S. S.

A. There is some diversity of opinion regarding some of these terms but general practice usually considers "load factor" as the ratio of average load to peak load. In each case, the interval of maximum load and the period over which the average is taken should be definitely specified, such as a "half-hour monthly" load factor. The proper interval and period are usually dependent upon local conditions and upon the purpose for which the load factor is used.

Load factor and "power load factor" are the same, since the former term has reference only to power. Load factor usually has reference to the entire plant and may perhaps be better termed "plant load factor." When it is used with reference to a particular unit, it is termed "machine load factor" or "engine load factor."

Diversity factor is used to express the relation between the simultaneous demand of all individual consumers and the sum of the maximum demands made by these consumers; the sum of the maximum demands of the consumers for one year, no matter at what time they occurred, divided into the simultaneous greatest demand of these consumers for a like period, when expressed in per cent will give the diversity factor.

Demand factor, unless otherwise specified, is the maximum connected kilowatts of capacity divided into the actual kilowatts of demand and expressed in terms of per cent.

Editorial Comment

Investigating the Public Utilities

Hearings of the Federal Power Commission, inquiring into publicity activities of public utilities, came to an end on January 18, after seven days of presentation of evidence by the utilities. Commissioner McCulloch, who presided, excluded from the record a volume of 96 documents offered by the utilities' counsel but afterwards admitted the listing of 94 of the exhibits while declining to admit the documents themselves. It was the contention of Mr. Weadock, the utilities' counsel, that these documents revealed the details of an organized campaign to disrupt and socialize the industry of the country. The utilities have maintained that any propaganda they might have issued against government ownership was a defense against attacks on the principles of private ownership.

For three days, Preston S. Arkwright, president of the Georgia Power Co., was on the witness stand before the commission. He was the only witness called for the utilities. Inasmuch as he was president of the National Electric Light Association during most of the investigation last year (the inquiry began in April, 1928) it may be assumed that he represented fairly the sentiments of the majority of the utility companies.

Besides presenting a great deal of testimony regarding the questions of utility regulation by state commissions, public relations and the like, Mr. Arkwright was subjected to many questions regarding the utilities' attitude toward public ownership.

This phase of the inquiry seems to us most significant. It appears, from the reports, that the commission has endeavored to create the impression that in opposing government ownership the utilities were doing something wrong. Mr. Weadock, in presenting evidence for the utilities, sought to show that a concerted attack by various organizations favoring government ownership has been made on the utilities, who replied to it in their advertising and publicity.

Why is the principle of government ownership so sacred that objections cannot be made to it? Is it not one of the cardinal principles of Socialism? Does the Federal Trade Commission desire to create the impression that it advocates Socialistic principles? Why cannot municipally-owned utilities be allowed to stand on their own feet in competition, without being bolstered up by the Commission? After all, the citizen who pays the power bill knows which type of utility costs him the least and provides him with the best service in a given case. It seems that there is an inconsistency somewhere.

In short, the Federal Trade Commission, on the basis of the news reports sent out to the public in this case, will be judged by that public as nothing but a whitewash brush for the demagogs. It has prolonged this inquiry into the public relations activities of the power utilities for almost two years, permitting full publicity to any demagog who could stimulate the slightest inference that a giant power trust existed—an octopus, as many uninformed people like to think of it. But its real purpose comes to light when, after months of securing evidence for the prosecution, much of it taken from the utilities' own files, it gives the defendants only seven days to present their side of the case. More important than that, the presiding officer terminates the case with the amazing remark that it was not the function of the commission to admit evidence showing why any act of the utilities was performed but only evidence to show it was performed.

That certain utility companies and individuals have made mistakes is undoubtedly true, since no man is infallible. But to consider the farce that has been enacted before the Federal Trade Commission as an unprejudiced inquiry into utility practices taxes the imagination to the utmost.

Luck vs. Preparedness

How lucky Lindy is! Many persons think of Lindbergh's luck but give little thought of the why of his luck.

Most air pilots on landing, run the plane up the line, cut the motor and then walk away. Not so with Slim. He sits in the cock-pit for 15 minutes, cooling the motor down slowly—treating the motor as a motor should be treated. This is the way he does everything.

Lindy was lucky in his hop across the Atlantic but the reason he had luck was that not only was he fully informed about all apparatus attached to his plane but he carefully tested each part before he started. This is what he does with everything. In other words he never trusts to luck and therefore always has it.

Minor accidents in the stationary power plant are not likely to be so serious as in a plane but equipment in such plants operates under as exact physical laws as airplane equipment. Reliability of action is largely due to regularity and effectiveness of attendance.

Blowing down a boiler under full pressure and then allowing cold water to rush in will cause the boiler to leak because of the unequal contraction of different parts of the mass of metal during the rapid fall in temperature. When this procedure is even approximated, the scale and deposit in the boiler become very hard due to the drying effect of the heat of the metal.

In cooling down a boiler, the brickwork should be permitted to cool for not less than two hours or destruction will result. When there is much sediment in the boiler, longer time must be allowed. After a boiler has stood banked for some time, the fact that it registers a considerable pressure should not be the basis for assumption that the temperature is uniform. It is likely that the bottom shell plate of an h.r.t. boiler, under such conditions, would be cold. The boiler, therefore, should be "circulated" for about a quarter of an hour

before putting it into service. A boiler easily may be ruined by careless steam raising when quite new and the damage can never be rectified entirely by calking or other repair measures.

Tightening leaky joints when the boiler or piping is under steam has been responsible for many fatal accidents. It may safely be said that water hammer has caused more fatal accidents than anything else, not including boiler explosions.

Danger of destruction should not be the only concern; capacity of a power plant is limited by its physical condition and no amount of attention will obtain satisfactory results from apparatus which has been allowed to get into bad repair. Often ordinary reciprocating pumps receive little attention when working. When such a pump commences to stick at one end of the stroke, many engineers simply shorten the stroke by screwing up the nuts which regulate the travel of the steam valve. The result is that the amount of water delivered is reduced and steam and water cylinders become grooved over a corresponding length. The piston rod will also wear unevenly so that, when the valve gear is finally given proper attention and the pump once more regulated to work at its normal stroke, the expected smooth working is not realized.

Even apparently insignificant neglect of good operating methods may cause trouble, loss of efficiency and perhaps destruction. Use of linty cloth for cleaning gage glasses is likely to result in trouble. A scratch from a metal rod, about which the cloth is wrapped for cleaning a glass, is likely to result in a crack.

Appearance is not the only reason for the more efficient operation of a tidy plant. Small leaks are indicative of some maladjustments or incorrect method of operation. Oil spilled around burners, fronts and floors, accompanied with lack of ventilation, may lead to a serious explosion.

Lindy was lucky! He could rely upon performance of his machinery because he did not believe in luck but pinned his faith on preparedness. Every power station can enjoy Lindy's luck.

To Make or Not to Make

It is impossible for Power Plant Engineering or anybody else to say that the industrial plant in general should make its power or buy it. What we do maintain firmly, however, is that each case in which the question arises should be investigated carefully and the decision reached that will be most satisfactory under the conditions of that particular plant.

Thus we often hear with amusement the reasonings of both the central station and the industrial plant. The industrial plant owner sometimes maintains stoutly that he can generate power and steam more cheaply than he can buy it, whereas his true situation may be merely that he insists on being independent of everyone and that he doesn't really know what his power is costing him.

For example, a prominent utility company desired to sell power to an industrial plant that generated all its own steam and power. After much debate, the utility proposed that it should purchase the power plant of the industrial company, operate it and sell steam and power to the plant at a lower price than that for which the industry could make them. This was done and at the end of the second year, the power plant was showing a small net profit—2 or 3 per cent—on the investment, at the same time supplying power for the industry at lower cost than they paid when making it themselves. The reason is obvious; good management and accurate analysis of the conditions.

Let us turn to the other side of the picture.

A consulting engineer of our acquaintance recently analyzed the power requirements of a large industrial plant and laid out the general design of a power plant for it to give a certain percentage of return on the investment. The industrial executives hesitated to build the plant because they maintained that the same amount of money put into production machinery would yield them a greater return. The consulting engineer reminded them that they were assuming the existence of a market that would absorb the product of the increased production machinery, a market in addition to what they now have. He also pointed out that, in their analysis, they ought to consider whether or not it would cost more to make and distribute the product to this new market. In short, are they anywhere near the saturation point of their particular market at this time? If so, will not the selling of the final 5 or 10 per cent of product cost so much that the additional profit will be eaten up?

Finally, the consulting engineer proposed, if the industrial executives did not want to build the power plant, that they give him a contract for the service and let him build it. He knew of people, he told them, who thought it a good enough investment to be willing to put their money into it. That, he pointed out, was the very thing the central station does and the public utilities are considered among the best investments today. These arguments finally convinced the industrial men that they had best consider carefully the question of installing their own plant.

Not long ago, Power Plant Engineering described how an industrial company formed a separate power company, sold bonds of the latter and in seven years will have them paid off and will then own a modern power plant that will be extremely economical to operate.

All this recital leads again to the dog-eared maxim that it doesn't pay to generalize, which we have repeated for years and will continue to repeat as long as conditions warrant it. Another conclusion from the above is that after all, the solution depends on the men behind the machinery. Only when engineers and industrial executives are able both to get at the facts and to understand what they mean, can a correct solution be reached of the recurring problem of whether to make or buy power.

VISCOSITY is that property of a liquid which resists any force tending to produce flow. It is independent of specific gravity and is usually expressed as the time required for a definite volume of liquid to flow through a given size and shaped orifice under a known head. Saybolt Universal (U. S.), Redwood (Great Britain) and Engler (German) viscosimeters are all commonly used. It is possible to convert readings from one scale to the other.

Power Plant Engineering Developments and News

Westinghouse Battery Charger

FOR CHARGING BATTERIES by means of copper oxide rectification, a new Rectox rectifier is announced by the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa. Employing the copper oxide principle, this charger presents a simple, safe and satisfactory means for charging storage batteries in all applications.

Simple to operate, it is necessary only to plug the Rectox into any available lamp socket, attach the direct

THE NEW WESTINGHOUSE BATTERY CHARGER

current leads to the battery terminals and turn on the switch mounted on top of the charger. A few hours' charging will put renewed life into the battery with no attention whatsoever.

Being light in weight, the Rectox can be moved to the battery easily. The trouble usually encountered in moving heavy batteries is eliminated. There are no parts to wear out or replace, with the exception of fuses which protect both the a.c. and d.c. circuits. No chemicals or acids are used and there is no danger of explosion or corroding fumes.

The rectifying unit consists of a long life, dry-type rectifier, made from copper. The copper oxide principle of rectification takes advantage of the electrical properties of copper, coated with a layer of copper oxide. The unit formed in this way allows electric current to pass in one direction only. Since there is no electrolytic or chemical action, the Rectox does not wear out.

This charger can be used in the home, in public garages, industrial plants, central stations and anywhere a storage battery needs charging.

High-Temperature Cement

NEW HIGH TEMPERATURE cement which will be added to its line of Adaproducts and sold under the trade name of Adachrome Plastic Super-Cement has been developed by Botfield Refractories Co., Swanson and Clymer Streets, Philadelphia, Pa. In this new cement, the basic material is a chromite ore obtained from South African deposits.

Because of its chromite base, Adachrome Plastic Super-Cement, it is claimed, is chemically-inert, hard, dense and highly refractory. Furthermore, the new cement employs a bonding agent which is stated to be extremely efficient at high temperatures.

Among the destructive furnace actions to which this new cement is designed to be resistant are basic and acid slags, molten metal penetration, abrasion, erosion and chemical reaction in the burning of acid sludge. In addition, the material, when applied as a surface coating on boiler settings, is intended to protect the brickwork from the penetrating action of clinker and fusible coal ash. The material is suited for making either dipped or troweled joints.

Another feature of the new cement is stated to be its plasticity, which contributes to ease of handling and working. The material is recommended by its manufacturer for laying up fire clay brick, silica brick, chrome brick, high-alumina brick and also for laying up magnesite brick under certain conditions. It is also adaptable for use as a surface coating material and as a binder in the mixture of patching materials for repairing burned-out sections of refractory construction.

This new cement will be packed in heavy gage metal drums with full-size openings to add to convenience of use. The drums have air-tight covers to prevent waste or deterioration of the material. Two sizes of drums, 250 lb. and 500 lb., are available.

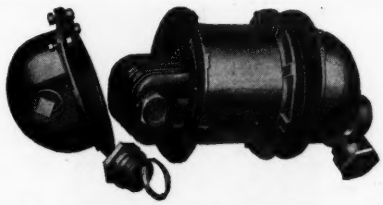
WHERE EXHAUST STEAM is to be used in process heating and to manufacture certain products of a particularly perishable nature, the problem of lubrication is unusually important, for constant vigilance is necessary to prevent oil spots or contamination. As a general rule, compounded cylinder oils are usually preferable in such plants, because saturated or wet steam conditions prevail. Therefore, to accomplish effective lubrication in steam engine cylinders, an oil must be used which contains a certain amount of animal fat in order to promote emulsification or lathering, increase the adhesiveness of the lubricating film and counteract the washing-off action of the moisture.

Aulbras Water Heater

CERTAIN FEATURES in the design of the new Aulbras hot water heater have directed attention to it since its recent appearance. Among these features is the fact that the Aulbras is entirely non-ferrous, to eliminate corrosion and rust; also the heater is designed to require no shutdowns for cleaning.

Domestic water, it is claimed, is as clean when it leaves as when it enters the heating element. Domestic water flows through a wide waterway designed to expose the greatest surface to the heating element and yet offer a minimum of resistance to the passage of water. So small is the friction loss that there is practically no decrease in gravity circulation, it is stated.

Exterior of the heating unit is stream-lined, to form a minimum resistance for the passage of the heating



NON-FERROUS WATER HEATER DESIGNED FOR RAPID HEAT TRANSMISSION

medium and to provide for a rapid flow of the heating medium and a consequent rapid transmission of heat to the domestic water.

Heat exchanger element consists of hollow sectional brass baffle plates, especially designed to allow a free and uninterrupted flow of the heating medium both horizontally and vertically around the exchanger element. Because of this construction, the exchanger element is equally adapted to installations in either horizontal or vertical position.

Contact between the domestic water unit and the outer case is provded by two solid rings. The difference in the coefficients of expansion between the metals provides a flexible joint and a free floating movement without resistance, to permit the laws of expansion to act without twisting or wrenching either heating unit, casing or supporting pipes.

One of the principal advantages claimed for the Aulbras water heater is that when used horizontally or vertically there is a straight waterway instead of a friction-producing return.

Heads of Aulbras heaters are reversible, to permit the heater to be used with equal facility in any vertical or horizontal position. There are two types of Aulbras heaters suitable for indirect (below the water line), and dual type (above and below the water line).

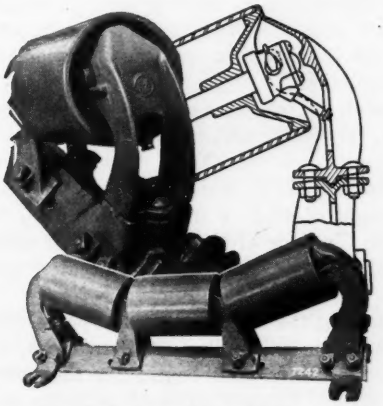
Capacities of these heaters range from 60 gal. to 5000 gal. with a temperature rise of 100 deg. in three hours. In size these heaters range from 22¼ in. long by 5½ in. in diameter to 76⅝ in. long by 9 in. in diameter.

While Aulbras heaters are primarily designed for heating water, their usefulness is by no means confined to any one fluid. Among the interesting applications of the heater is the preheating of fuel oil. This highly viscous fluid, often too heavy to flow at ordinary room temperatures, has been successfully heated to the desired temperature in an Aulbras heater. The new heater is a product of Rome Brass Radiator Corp., One East 42nd St., New York.

Timken Bearings for Improved Stephens-Adamson Carriers

IMPORTANT REVISIONS in both its Sacon and 444 Carriers for heavy duty belt conveyors have been made by Stephens-Adamson Mfg. Co., Aurora, Ill. These idlers are practically alike except for the cross supports upon which the rollers are mounted. The Sacon is mounted upon a heavy structural steel angle while the 444 rollers are supported upon two cross shafts of large diameter. The 444 mounting is designed to permit any carrier to be tilted back onto the conveyor deck, where the carrier can be inspected or removed without stopping the belt.

The improved Sacon is shown in the accompanying illustration; it includes double Timken roller bearings for each self-aligning bearing, belt rollers with end castings to prevent collection of material and moisture and a new hood type end bracket to protect the outer bearings.



IMPROVED SACON CARRIER

Sacon and 444 carriers now feature: three-pulley design of great strength requiring the least possible power to start and to run; entire carrier tilted at the proper angle to train belt; closely spaced rollers of heavy 6-in. steel tubing with self-cleaning malleable pulley ends; live shaft turns with each roller to decrease bearing wear to minimum; two bearings for each roller, with self-aligning bearing housings equipped for pressure lubrication; double Timken roller bearings for each bearing. Double or single ball bearings can also be furnished where desired; hood type outer brackets to support and protect bearings; entire carrier rigidly built of steel and malleable iron.

Robbins & Myers ⅛ to 7½-T. Electric Hoists

COMPLETE LINE of electric hoists in sizes ranging from ⅛ to 7½ t. capacity is announced by the Hoist & Crane Division of Robbins & Myers, Inc., Springfield, Ohio. Outstanding features incorporated in these new hoists, it is stated, are: Improvement in design to

save both weight and space in all dimensions, headroom included; cast-steel trolley adjustable to nine sizes of I-beams; safety constructed enclosed bottom block to retain the rope on the sheaves and shroud all parts so as to guide itself easily into the rope flare when swinging; gearing of alloy steel, heat treated to rigid specifications to allow for the maximum strain of constantly reversing tooth loads at top motor speed; Hyatt roller bearings specified by and applied with the approval of the Hyatt Roller Bearing Co. in the hoisting mechanism; main frame of Aremite alloy metal, produced in the Robbins & Myers foundry by electric process, which has a tensile strength of 35,000 lb. per sq. in., with an elasticity which enables it to stand shock more readily than cast iron and a better finished appearance than cast steel; aluminum finish applied throughout to give attractive appearance and provide lasting protection against damage from exposure.

Four Giant Electric Generators for Russia

FOUR 77,500-kv-a. hydroelectric generators, the largest in the world, are being manufactured by the General Electric Co. for the Dnieper River development at Kichkas, near Zaporozhe, in the Ukraine. The development will supply power in the vicinity of Dnepropetrovsk, and through the southern part of the Union of Socialist Soviet Republics.

The total weight of each generator will be approximately 1,760,000 lb. while the weight of the rotor and shaft will approach 980,000 lb. The maximum diameter is approximately 42 ft. while the generators will have an overall height of 40 ft. 5 in., of which 17½ ft. will extend above the floor of the plant. Large castings have been eliminated by the use of fabricated welded construction.

Shipment of the several thousand parts will be made by railroad from Schenectady to New York, where they will be loaded on a boat bound for the mouth of the Dnieper River. Though railroad facilities in that section of Russia are considered good, part of the shipment will be made by barge up the river to the site of the plant, where a special 50-t. crane will have to be installed to handle the pieces of apparatus. About 130 railroad cars will be required for the shipment.

Because of shipping limitations, the stator of the generator will be made in six sectons, the punchings and windings to be assembled in each unit at the factory. The rotor will be completely dismantled for shipment. The heaviest single piece to be handled will be the 40-in. steel shaft, 36 ft. long, with a coupling flange on the end which is 70 in. in diameter. This part will weigh about 136,000 lb. It will be shipped on a special car, as will the hub for the upper bearing bracket, which is 16 ft. in diameter. This latter piece will be routed a roundabout way from Schenectady to New York to insure railroad clearance. The last of the four units is scheduled for shipment early in 1932.

All of these vertical generators will be driven by water turbines being built by the Newport News Shipbuilding and Dry Dock Co. Hugh L. Cooper & Co., New York, the consulting engineers, are now at work on the construction of the dam and power station.

Death of Thomas Shipley

IN THE DEATH of Thomas Shipley, president and general manager of the York Ice Machinery Corp., which occurred at his home, 505 Roosevelt Avenue, York, Pa., on Wednesday morning, January 22, the refrigerating industry has suffered the loss of an outstanding figure. His personality had so impressed itself upon all connected with refrigeration that the news of his death came as a great shock.

Mr. Shipley had been continuously identified with the refrigerating industry since 1884. The York company, when he joined it in 1897, was one of the smaller concerns manufacturing refrigerating machinery, employing about 50 men. Under his leadership and with his tremendous driving force urging it forward, the company grew to its present proportions.

THOMAS SHIPLEY

Mr. Shipley was born in Jersey City, N. J., June 30, 1861. He was educated in the public schools of that city and at Cooper Union, New York, from which institution he was graduated in 1881 in mechanical engineering.

His first employment was found with the Morris and Cummings Dredging Co., Jersey City. His next venture was in making ice machinery, the firm then trading as Wood and Shipley, in 1884. In the fall of 1886 he went to Waynesboro, where he was connected with the Frick Co. in refrigerating engineering work. In 1892 he left Waynesboro and went to Steubenville, Ohio, and for three years he was engaged in the operation of two ice plants, one in Steubenville and one in Pittsburgh. In 1895 he returned to the Frick Co. and became manager of the ice machinery and refrigeration department. In 1897 he went to York to become general manager of the York Manufacturing Co.

Notwithstanding demands made upon him in the conduct of his growing business, Mr. Shipley at all times took a prominent part in the promotion of professional and trade groups, aiming to develop the industry and enhance the prestige of the refrigerating engineer. He was one of the founders in 1903 of the "Ice Machine Builders' Association of the United States" now the "Refrigerating Machinery Manufacturers' Association," and a leading member and contributor to the publications of the American Society of Refrigerating Engineers, of which he was the eighth president. He

was a member of the American Society of Mechanical Engineers and numerous other bodies. No part of the work which Mr. Shipley did in furthering refrigeration was dearer to his heart than the standardization of equipment and the setting up of a standard or unit ton of refrigeration. He was the inventor of many devices and methods pertaining to refrigeration. The salient features of these developments were set forth in numerous technical papers.

Death of Francis Cole Pratt

FRANCIS COLE PRATT, former vice-president and chairman of the manufacturing committee of the General Electric Co., died January 26, in New York City, after an illness of six weeks. Born in 1867 at Hartford, Conn., he was graduated from the Sheffield Scientific School of Yale University with the degree of Ph.B. in mechanical engineering in 1888. After graduation, he was associated with the Pratt and Whitney Company, machine tool manufacturers, of which his father was president and one of the founders, continuing with them until he became vice-president.

He joined the General Electric Co. in 1906 as assistant to E. W. Rice, in charge of manufacturing and engineering. He was made assistant to the president in 1913 and was elected vice-president in 1919. As vice-president, he at first had charge of engineering and later of both engineering and manufacturing. He retired in 1927.

Mr. Pratt was a member of the munitions standards board of the United States council of national defense in 1917, a trustee of the Sheffield Scientific School, a trustee and former head of the Hospital Association of Schenectady, a former trustee of the Albany Medical College of Union University, and former president and member of the executive committee of the Yale Engineering Association. The honorary degree of M. A. was conferred upon him by Yale in 1925.

MANUFACTURING CONCERNS in any part of the country, which face production and distribution difficulties incident to plant location, will have at their disposal in the solution of these problems the technical engineering staff of the newly organized Industrial Development Bureau of the Niagara Hudson Power Corp. of New York, it has just been announced.

The Bureau has been organized to promote the industrial development of New York State, not as a matter of philanthropy but as a sound business policy. The corporation's announcement stated that increased industrial activity will mean more business in every direction, naturally including increased consumption of power.

The Industrial Development Bureau will maintain an expert industrial engineering staff, equipped to analyze the specific problems of industrial concerns as well as the peculiar industrial advantages of communities and districts in the State. It will be prepared to make exhaustive surveys of the operation and production problem of any industry. Naturally its findings will be available only to the industry concerned. The Bureau will be under the direction of Don G. Mitchell, industrial development expert. The main office of the Bureau is in Albany, N. Y., with branches in Buffalo and Watertown, N. Y.

Death of W. J. A. London

WILLIAM JAMES ALBERT LONDON, works manager of Reider-Ericsson Co., Walden, N. Y., died suddenly of apoplexy on November 14 at his home in Walden. Born at South Hylton, Durham County, England, in 1877, in 1893 he was apprenticed to C. A. Parsons & Co. at the Heaton works, Newcastle-on-Tyne, where he attended the Armstrong College. Completing his apprenticeship, he became a leading draftsman and was associated with the early stages of reaction turbine development. In 1900, he joined Brown, Boveri Co. of Baden, Switzerland, and in 1902 entered the employ of the British Westinghouse Co. at Trafford Park, becoming responsible for the steam turbine developments being undertaken there.

In 1906, George Westinghouse, impressed with London's versatility as a designer, had him transferred to

W. J. A. LONDON

the East Pittsburgh works of the Westinghouse Machine Co. where he carried on experimental work with marine propulsion. This work finished, he accepted in 1908 a position as chief engineer of the Terry Steam Turbine Co. In 1915, London left the Terry Co. and after a short period of consulting service for the Sterling Blower Co., joined the General Electric Co. of Lynn, Mass., in charge of design on certain of the smaller turbines.

In 1916, he organized the Steam Motors Co., serving as chief engineer and general manager until 1922, when it was taken over by the Troy Machine Co. He then organized the London Steam Turbine Co. Mr. London had been carrying on work with coal pulverizers since 1919, giving much of his time to consultation with Combustion Engineering Co. In 1927, associated with Peabody Engineering Co. he undertook some developments in coal pulverization at the works of the Reider-Ericsson Co.

At the successful conclusion of these tests in January, 1929, he became works manager of the Reider-Ericsson Co. He was a member of the American Society of Mechanical Engineers, Institute of Naval Architects and Marine Engineers, the American Society of Naval Engineers, Engineers Club of New York and associate member of the Institute of Mechanical Engineers of Great Britain.

COMPRESSION and early admission are two methods used to cushion a steam piston.

State Line Goes to 1200 Lb. 825 Deg. F.

USE OF 1200 lb. pressure and 825 deg. F. total steam temperature, the highest temperature yet considered in this country for a large machine, will be one of the interesting features of the second section of the State Line station.

Total capacity of the second section will be 275,000 kw. in two units, one a 125,000 kw. 85 per cent power factor Allis-Chalmers unit, the other a 150,000 kw. 90 per cent power factor General Electric unit.

In addition to the high temperature used, the turbine construction itself is unusual. In the Allis-Chalmers machine, steam from the high pressure cylinder will be reheated at 400 lb. pressure to 825 deg. F., again introduced into the high pressure cylinder and expanded to the cross-over pressure of 15 lb. absolute at which pressure it will enter the low pressure element.

Addition of these two units will increase the capacity of the station to 483,000 kw. the second largest station in the Chicago district. It is expected that the addition will be completed sometime around the early part of 1932. Babcock & Wilcox will supply the boiler units.

State Line Station, on Lake Michigan at the Illinois-Indiana state line, was put into operation last summer. The first unit was a 208,000 triple element turbine using 650 lb. 730 deg. steam and with steam reheat at 71 lb. to 500 deg. F.

News Notes

DISCUSSION of subjects at the World Power Conference to be held in Berlin June 15 to 25, at which 49 nations will be represented, will be divided into four classes: A, Sources of Power; B, Power Production, Transmission and Storage; C, Utilization of Power; D, General Subjects. Among American authors who will present papers are to be W. S. Lee, H. D. Savage, E. G. Bailey, A. G. Christie, Fred G. Straub, W. F. Ryan, V. M. Motsinger, W. M. Dann, Marshall E. Sampsell. Arrangements are in progress for visits to factories, power stations, technical colleges, iron works and ship yards during and after the Conference. For the convenience of the large number of delegates expected from the United States, the S.S. Resolute entire first cabin has been chartered, sailing from New York June 4 and arriving at Cuxhaven the 13th whence a special through train will be run to Berlin. Arrangements are in charge of the American Committee, Edmonds Building, Washington, D. C., and details and costs may be obtained by writing to O. C. Merrill, chairman.

C. J. TAGLIABUE MFG. CO., Brooklyn, N. Y., has opened a branch factory at 417 Lake St., Shreveport, La., in charge of C. L. Huffman, district manager. The primary function of the new factory will be repair work, with special attention to emergency orders. Stocks of all standard equipment will also be maintained.

POINTING THE WAY TO BETTER BOILER ECONOMIES is the title of a recent loose-leaf, 16-page bulletin issued by the Hoppes Manufacturing Co., Springfield, Ohio. This describes in detail Hoppes deaerating heaters, feedwater heaters and purifiers, steam and oil separators and exhaust heads.

GIRTANNER ENGINEERING CORP. announces that since February 1 its main office has been located at its plant at Palmyra, N. J. The New York sales office is now located at Room 419, 30 Church St., New York City.

IN CONNECTION with the general expansion program of The Austin Co., international firm of designers and builders, George A. Bryant, Jr., executive vice president and general sales manager, announces the appointment of Ralph Leavenworth as assistant general sales manager, to have contact with sales activities at the headquarters office at Cleveland and the various branch offices throughout the country. Prior to joining the Austin staff, Leavenworth was secretary and account executive of Paul Teas, Inc., advertising agency, handling the account of The Austin Co. The Austin Co. has announced that it is inaugurating noiseless construction of industrial and commercial buildings with the electric welding of structural steel as a regular part of its service. The company will make welding or riveting optional with the owner. Expansion of 50 per cent in the company's fabricating plant facilities is involved.

ANNOUNCEMENT IS MADE that the Pyrites Co., Ltd., has discontinued its American branch as of December 31, 1929. The Pyrites Co., Inc., an American corporation, recently formed under the laws of Delaware, has taken over the American business, assumed all its obligations and liabilities and acquired all its assets. There has been no change in personnel.

EDWARD VALVE & MANUFACTURING CO., East Chicago, Ind., announces that headquarters for the sale of its products in the Easton-Allentown-Reading district of Pennsylvania are now located at 1121 Maple St., Bethlehem, Pa. The company is represented by W. E. Groff, who succeeded to the business of W. E. Groff Co., Inc., of Easton.

AGREEMENT between the Rockford, Ill. City Council and the Rockford Electric Co. by which the latter would pay $200,000 annual franchise tax, increasing $5000 annually after the first 10 yr., has been rejected by the utilities company, Adam Gschwindt, general manager, notified the council, after that body had changed the terms to make the $5000 increase effective after the first five yr. The utilities officials said the action of the council amounted to a dictatorship by one member and that it could not become a party to such procedure. The action ends efforts to compromise on the franchise tax of two per cent upon revenue from commercial lighting, which is already pending in the courts because of the company's claim that 50 per cent of this revenue is deductible as not derived from commercial users. Suit for $50,000 filed by the city is now pending in the courts and J. Herman Hallstrom, mayor, has asked a special appropriation of $10,000 to prosecute the suit.

RILEY STOKER CORP., Worcester, Mass., advises that Harold G. Meissner will be associated with its New York office as sales engineer.

WAGNER ELECTRIC CORP., St. Louis, Mo., announces the transfer of L. J. Dicianne from the position of branch manager of the Minneapolis Office to the branch managership of the Kansas City Office. The company also announces the appointment of Major Elam as branch manager of the Minneapolis territory.

OSBORN ENGINEERING CO. is announcing a reorganization this month. P. P. Evans is the new president of the organization, with which he has been associated for 30 yr. E. H. Birney, formerly president of the Peerless Drawn Steel Co. of Massillon, Ohio, becomes the new vice-president. T. T. Hubbard, director of the company since 1912, is to be the treasurer and Kenneth T. Osborn, son of the late F. C. Osborn, who founded the company in 1892, is the secretary.

MASON REGULATOR CO., Boston, Mass., announces the appointment of the O'Brien Equipment Co., 2726 Locust Blvd., St. Louis, Mo., as exclusive distributors in the Missouri territory.

NEW SELF-LUBRICATING BRONZE BEARING has just been announced by Johnson Bronze Co., New Castle, Pa. The new bearing is designed to provide for a uniform area of bearing surface on the pressure line and to insure an efficient distribution of lubricating compound. The compound used is also a Johnson Bronze development. Improved results are obtained, it is claimed, by a new method of effecting indentations in the metal and by placing them on a bevel of 30 deg.

Much interest has been evinced in the new bearing, it is stated, especially by the makers of machinery and parts subject to intermittent or periodical operation, such as brake levers, clutch levers, shock absorbers, rocker arms, slow running journals, starting motors, landing gears, guide rollers, sliding door rollers and the like.

SINCE January 2, 1930, the interests of Worthington Pump & Machinery Corp. in the California territory have been served through a local company, the Worthington Machinery Corp. of California, Ltd., with headquarters at Los Angeles and San Francisco. H. D. Cornell, who has been president of the Worthington Machinery Corp. of Oklahoma will be president of and direct the new corporation, moving to California for that purpose. George W. Hawkins, who has been director of sales, will also go with Worthington-California, as vice-president. The new corporation of California will take over the sales and engineering staff and the warehouse facilities of the Worthington Co., Inc., in California, and will hereafter handle all that territory.

APPOINTMENT is announced of Joseph V. Santry as head of Combustion Engineering Corp. of New York to succeed Colonel H. D. Savage, who is assisting the receivers, Wilfred R. Wood

and the Irving Trust Co. Mr. Santry, who became identified with the corporation shortly after its organization in 1914, served as director and vice-president in charge of sales for 5 yr. and as president for 4 yr., resigning about 2 yr. ago.

General Refractories Co., Philadelphia, Pa., announces that it has acquired all of the refractories properties of Evens & Howard Fire Brick Co. of St. Louis, Mo. The Evens & Howard Fire Brick Co. has been a manufacturer of fire brick since 1857 with plants located in St. Louis, Mo., and Stevens Pottery, Ga., having total combined daily capacity of 180,000 brick per day. The purchase includes not only the plants and business of Evens & Howard Fire Brick Co., but also its clay lands in Missouri and Georgia. This now gives General Refractories Co. a total of 18 plants. The Evens & Howard plants will be operated by General Refractories Co. as the Evens & Howard Division and the brands of the old company will be continued.

Chicago Association of Consulting Engineers held its annual meeting at the City Club, 315 Plymouth Court, Chicago, on Monday, January 20, 1930. Preceding the general meeting, an election of officers for the ensuing year was held. The following were reëlected: Ernest V. Lippe, president; Rollo E. Gilmore, vice-president; H. L. Clute, secretary-treasurer, 307 N. Michigan Ave., Chicago, Ill. Among the features of the technical program of the annual meeting was an illustrated talk by A. H. Goelz on the Trend in Refrigeration.

W. H. Bixby, Inc., has moved its main office from Omaha, Nebr., to 1004 Hubbell Building., Des Moines, Iowa. It is representative for American Engineering Co. of Philadelphia, Pa.

H. K. Ferguson, Cleveland, Ohio, announces the establishment of a branch office at 520 North Michigan Boulevard, Chicago, Ill. Henry Maag, an engineer and member of the Ferguson organization for 10 yr., has been appointed branch manager.

For the degreasing of metals and other impervious materials, a new vapor bath process has been developed by the Carrier Engineering Corp., Newark, N. J. In this process, a solvent known by the trade name of Cecolene is boiled and vaporized. In the standard tank form of the apparatus, the vapor rises to the level of water-cooled condenser coils around the sides near the top of the tank, is condensed and then is precipitated to the bottom of the tank. Since the vapor is more than three times as dense as air, there is no tendency to overflow or escape, it is stated.

Objects to be degreased are suspended in the vapor, which condenses on their cooled surfaces at once and runs off, carrying the grease with it. Objects are kept in the vapor until they heat up to its temperature, from 1½ to 3 min., depending on the thickness or weight of the material. They are then removed and any foreign matter remaining is in the form of dust that can be easily removed. Economy results, it is stated, from the fact that the solvent can be used over and over again, as the vapor does not become dirty. The degreaser is to be made in standard dip tank units and in special design adaptable to any size or style of continuous conveyor in line assemblies and to steam, gas or electric heating.

As part of the National Management Congress, an evening session on Elimination of Waste will be held on March 3 at the Hotel Stevens, Chicago, Ill. C. B. Auel, chairman of the Elimination-of-Waste Committee, has announced that this will be the opening meeting of the Committee's 1930 Elimination-of-Waste drive. The month of April has again been set by the Committee as the time for the Annual National Elimination-of-Waste Campaign.

Announcement comes from Lausanne, Switzerland, of the death of M. P. Piccard, who built the first turbines for the power plant at Niagara. He was 86 yr. old.

Maintenance Engineering Corp., 1400 Conti St., Houston, Texas, now represents The Edward Valve & Manufacturing Co. in the El Paso territory, which includes southern New Mexico and western Texas.

James Cleary has been appointed general sales manager of Combustion Engineering Corp., New York, and will assume his new duties at once. Mr. Cleary joined the organization in 1921 and has served successively as district manager at Philadelphia and Detroit, assistant general sales manager, and western manager with offices at Chicago.

Westinghouse Electric & Manufacturing Co. plans an expenditure of $1,500,000 for a central engineering laboratory and an addition to the present direct-current power laboratory, both in East Pittsburgh, Pa., according to an announcement by F. A. Merrick, president of Westinghouse. Large generators will be installed, together with artificial lightning equipment for testing insulating materials, and apparatus for making artificial weather for testing outdoor equipment. The new laboratory, says Mr. Merrick, will eventually replace numerous smaller laboratories and experimental testing sections now scattered throughout the plant. Work has already started on the laboratory which is an 11-story structure, 88 ft. wide and 225 ft. long, with an 125-ft. extension to the direct-current laboratory.

E. H. Pearson, New York district manager of Electric Machinery Mfg. Co., Minneapolis, Minn., died suddenly on December 7. Mr. Pearson was born in Malmo, Sweden, in 1893, and received technical education at the Institute of Technology in that city. Coming to Minneapolis, he began work with Crown Iron Works as electrician and in 1916 entered the employ of Electric Machinery & Mfg. Co., as a service engineer. In the fall of 1921, he entered its sales organization and in 1928 was made manager of the New York district office. He was a member of the American Society of Refrigerating Engineers, American Institute of Electrical Engineers and American Society of Swedish Engineers.

Catalog Notes

Ash pumps are discussed in bulletin No. 1229 by Allen-Sherman-Hoff Co., Philadelphia, Pa. In this 20-page, illustrated bulletin are described vertical pumps for ash-laden water, methods of installing them and many data on their application and operation.

Foxboro Steam Flow Meters are described in Bulletin No. 162 by The Foxboro Co., Foxboro, Mass. This bulletin discusses steam flow measurement, coefficients, theory of steam flow meters, then gives detailed description of the Foxboro meter, illustrated by colored cross section showing manometer, float and meter driving mechanism. This is followed by details of the construction of various parts and the bulletin concludes with discussion of steam meter piping layouts and design and location of orifices.

Type WD-200A Arc Welder for belt, motor or gas-engine drive is described in bulletin GEA-874E by General Electric Co., Schenectady, New York. This welder is stationary or portable, self-excited, variable-voltage, single-operator type, rated at 200 amp., 25 v., 1 hour, 50 deg. C. Bulletin GEA-875E describes the type WD-300A arc welder, similar to the preceding one except that it is rated at 300 amp., while the 400 amp. unit is described in bulletin GEA-876D. In bulletin GEA-987A, the company describes station oil circuit breakers, type FK-330 and FHK-330. These are for 15,000 to 25,000 volts and 600 to 4000 amp. GE beam clamps for attaching all forms of outdoor devices to structural steel members are described in bulletin GEA-1192.

Rock Wool insulation is described and its applications illustrated in a 48-page bulletin, No. 400, recently issued by General Insulating & Manufacturing Co., Alexandria, Ind. This describes the raw material, silica rock, from which Gimco Rock Wool is manufactured and then gives details of its applications showing by drawings how it is installed for different types of work. Tables of dimensions and weights are given, also a table of thermal conductivities of various materials. Photographs and diagrams show various ways in which it has been applied.

Westinghouse Electric and Mfg. Co. announces the publication of Leaflet No. 20,442 describing the Combination Sharples Centrifuge and Filter-press Oil Purifier, which has recently been placed on the market. The leaflet contains a detailed description of the construction and manner of operation of the purifier accompanied by several pictures and diagrams.

Bridge-Meg Resistance Tester, designed for resistance from 0.01 ohm to 100 megohms, is described and illustrated in Bulletin No. 1255 by James G. Biddle, 1211 Arch St., Philadelphia, Pa.

Combustion Systems, boiler settings, furnace linings and special refractories are described in an 8-page bulletin by the Essex Engineering Co., Inc., Belleville, N. J. Special attention is given to methods of using the Universal air-cooled block, its applications being shown by several detailed sketches and photographs.

Modern Power Plant Equipment, a 48-page cooperative book, has been issued by the International Nickel Co., Inc., 67 Wall St., New York, N. Y. This discusses the results obtained in power plant equipment and in many industries by the use of nickel and monel metal. The book contains reprints of advertisements of 30 manufacturers that use monel metal in their products, showing, in many cases, how and why it is used.

In a new 24-page bulletin, No. 37, just issued by the Morse Chain Co., Ithaca, N. Y., the subject of flexible couplings is thoroughly discussed. Need for flexibility in power transmission, principle of Morse flexible coupling design, methods of installing and employing them, are explained. Complete data are given on the proper way to select couplings, their ratings, dimensions and prices. Speed reducers are also explained, as is the Morse Power Transmission Service.

Power Plant Construction News

Ala., Birmingham—The Gulf States Steel Co., Birmingham, plans installation of electric power equipment in proposed new sheet mill addition on which work will begin at an early date, entire project to cost more than $2,000,000.

Ariz., Phoenix—The City Council plans installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in municipal waterworks, for which a bond issue of $2,636,000 is being arranged. W. J. Jamieson is city engineer.

Calif., Coalinga—The Petroleum Securities Co., Los Angeles, will install electric and steam power equipment in connection with proposed rebuilding of portion of oil refining plant at Coalinga, recently destroyed by fire with loss reported at more than $300,000.

Calif., Los Angeles—The Liquid Carbonic Corporation, 3100 South Kedzie Avenue, Chicago, Ill., plans installation of electric power equipment in proposed dry ice and soda fountain accessory manufacturing plant at Los Angeles, entire project reported to cost in excess of $100,000.

Colo., Rocky Ford—The Southern Colorado Power Co., Pueblo, plans extensions and improvements in power substations at Rocky Ford, Las Animas and Fowler, including installation of transformers, switchboards and auxiliary equipment.

Conn., Bridgeport—The United Illuminating Co., New Haven, Conn., is completing plans for an addition to steam-operated electric power plant at Bridgeport, to include the installation of a 12,500 kw. turbo-generator unit and auxiliary equipment.

Del., Wilmington—The Cork Insulation Co., 154 Nassau Street, New York, will install electric power equipment at proposed plant at Wilmington, where tract of 13 acres of land has been acquired, entire project reported to cost more than $100,000.

Ill., Belleville—The Belleville Stove & Range Co., Third Street, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss at more than $100,000.

Ill., Chicago Heights—The J. Friedlander Furniture Co., 181 East Sixteenth Street, plans installation of electric power equipment in proposed new factory addition to cost more than $100,000.

Iowa, Cedar Falls—The Common Council is planning extensions and improvements in municipal electric light and power plant on West Third Street, including installation of a steam turbine, condensers and auxiliary equipment, estimated to cost more than $100,000.

Iowa, Iowa Falls—The Central States Electric Co., Iowa Falls, is said to be planning a one-story addition to local steam-operated electric power plant, for boiler room and auxiliary service, reported to cost more than $60,000, with equipment.

La., Amite—The Louisiana Power & Light Co., New Orleans, plans construction of transmission line from Amite to Bogalusa, La., for service at mill of the Bogalusa Paper Co.; power substation at Amite will be enlarged and new power substation constructed at Bogalusa, entire project to cost more than $200,000.

La., Winnfield—The Gulf Public Service Co., New Iberia, La., plans extensions and improvements in power station and system at Winnfield, estimated to cost about $70,000.

Minn., Adams—The Village Council is reported planning the installation of a municipal electric light and power plant and will soon make estimates of cost. P. H. Carr is village clerk.

Minn., Marshall—The City Council has arranged for a special election to approve a bond issue of $100,000, for extensions and improvements in municipal electric light and power plant, to include installation of boilers and auxiliary equipment, switchboard facilities, etc.

Minn., Sleepy Eye—The Common Council is said to be arranging for immediate call for bids for extensions and improvements in municipal power plant, including installation of additional equipment. Toltz, King & Day, Inc., Builders Exchange Building, St. Paul, Minn., is engineer.

Mo., Kirksville—The City Council is said to have plans maturing for a municipal electric light and power plant to cost more than $200,000, with equipment.

Mo., Valley Park—The St. Louis Carbonic Ice Co., operated by R. H. Tait & Sons, Inc., 813 Hemptsead Street, St. Louis, plans new dry ice-manufacturing plant at Valley Park, reported to cost close to $50,000, with equipment.

Miss., Indianola—The Indianola Oil Mill Co., plans installation of electric power equipment in connection with proposed rebuilding of portion of local mill, recently destroyed by fire with loss in excess of $200,000.

Nev., Hawthorne—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is asking bids (no closing date stated) for a reënforced-concrete chimney at the naval ammunition depot, Hawthorne, as per Specification 5908.

N. J., Metuchen—The Pennsylvania Railroad Co., Thirty-fourth Street and Seventh Avenue, New York, has purchased property near Lake Avenue, Metuchen, for a new power substation to be used in connection with electrification of road between Newark and Trenton, N. J. Gibbs & Hill, Inc., Pennsylvania Station, address noted, is engineer for the project.

N. Y., Long Island City—The Colonial Dye Works, Inc. plans installation of electric and steam power equipment in proposed local dry cleaning plant, entire project reported to cost more than $100,000. Irving M. Fenichel, 114 East Thirty-second Street, New York, is architect.

N. D., Cavalier—The Common Council is reported planning the installation of a municipal electric light and power plant and will have estimates of cost made at an early date.

Ohio, Dayton—The Dayton Electrotype Co., 240 West Fifth Street, plans installation of electric power equipment in proposed plant addition, entire project to cost more than $100,000.

Ohio, Elyria—The City Council is completing plans and expects to take bids early in the spring for two pumping stations for the municipal waterworks, to cost about $40,000. J. Powell is city engineer. F. B. Gascolgne, Leader Building. Cleveland, is consulting engineer.

Okla., Oklahoma City—The Phillips Petroleum Co., Bartlesville, Okla., will install electric and steam power equipment in proposed gasoline refining plant near Oklahoma City, entire project reported to cost more than $100,000.

Texas, Sweetwater—The Magnolia Petroleum Co., Dallas, Texas, plans installation of electric and steam power equipment in proposed oil refining plant at Sweetwater, entire project reported to cost more than $3,000,000; a boiler plant will be built.

Utah, Mount Pleasant—The Common Council is reported considering the installation of a municipal electric light and power plant. Estimates of cost will soon be made.

Va., Norfolk—The Ford Motor Co., Detroit, Mich., will install electric power equipment in proposed additions to assembling plant at Norfolk, entire project to cost in excess of $1,000,000.

W. Va., Charleston—The United Fuel Gas Co., Charleston, is planning an expansion and improvement program in connection with natural gas and gasoline property, including transmission line extensions, installation of meter, regulator and compressor stations and other plant expansion, estimated to cost more than $1,500,000. H. A. Wallace is president.

W. Va., Kenover—The Tri-State Refining Co., plans installation of electric and steam power equipment in connection with proposed rebuilding of portion of oil refining plant, recently destroyed by fire with loss reported at close to $100.000.

W. Va., Wellsburg—The Harvey Paper Mills Co., Wellsburg, a subsidiary of the Pillsbury Flour Mills Co., Minneapolis, Minn., plans installation of electric power equipment in proposed addition to paper bag mill, entire project to cost about $200.000.

Wis., Milwaukee—The General Bronze Corporation plans installation of electric power equipment in proposed plant addition, entire project reported to cost about $100,000.

Wis., Monroe—The Allen Ice Cream Co., South Winnebago Street, Rockford, Ill., plans installation of electric power equipment at proposed plant at Monroe, entire project to cost about $65.000.

Wis., Thiensville—The Gilbert Shoe Co. plans installation of electric power equipment in connection with proposed rebuilding of portion of shoe factory, recently destroyed by fire with loss reported at close to $100,000.